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BIOMASS FUEL SUPPLY AND UTILIZATION IN THE CITIES OF THE DEVELOPING WORLD: A CASE STUDY OF CEBU CITY, PHILIPPINES

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ABSTRACT

BIOMASS FUEL SUPPLY AND UTILIZATION IN THE CITIES OF THE DEVELOPING WORLD: A CASE STUDY OF CEBU CITY, PHILIPPINES

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The island Province of Cebu is generally considered to represent one of the worst cases of extreme environmental degradation in the Southeast Asian region. Widespread dependence on woodfuels (biomass) by the island's 2.7 million inhabitants is often pointed to as a major cause of Cebu's environmental problems, prompting government and NGO officials in the region to call for tighter restrictions and regulation of the commercial woodfuel trade.

This dissertation was designed to assess the economic and environmental impact of woodfuel production and use in Cebu by focusing on three aspects of the local woodfuel system. First, a household energy survey was administered to 603 Cebu City households in order to quantify residential sector woodfuel consumption and determine the social, economic and cultural factors most responsible for observed fuel-choice and fuel-use

patterns. Second, approximately 100 rural and urban woodfuel traders were interviewed in order to examine how the commercial woodfuel trade functions. Third, rapid rural appraisal (RRA) surveys were conducted in eight woodfuel-producing regions of the province in order to investigate the impact that urban woodfuel demand was having on rural land use practices and resource management.

Fuelwood, charcoal and other biomass fuels account for approximately 50% of energy consumption in Cebu City's residential sector. Fuelwood is used predominantly in low-income households, charcoal is used in households of all incomes for specialized cooking. The commercial woodfuel trade in Cebu is a well-established, highly specialized and competitive industry, providing income and employment to 40,000 rural and urban Cebuanos. The bulk of commercially-traded woodfuels in Cebu originate from intensively-managed agricultural and fallow lands, not from forests. The presence of urban woodfuel and other wood product markets serves as a strong incentive for increased tree-planting and management in rural areas.

These results suggest that instead of being viewed as a problem to be controlled through punitive restrictions and regulation, commercial woodfuel markets in Cebu represent an opportunity to promote more widespread tree-planting and management on the island.

CHAPTER 1

ENERGY POLICY AND ECONOMIC DEVELOPMENT IN THE PHILIPPINES: 1973-2000

Introduction

The global oil crises of 1973-74 and 1979-80 had a profound impact on the economies and energy policies of developing nations of the world, resulting in fundamental changes in the way these nations produce, price and consume energy. Within Asia, few countries were as greatly affected by the oil price increases and supply uncertainties of the period as the Philippines, whose economy was dependent on imported oil for 92% of its commercial energy requirements in 1973. In the wake of the 1973 oil crisis, the Philippine government of Ferdinand Marcos initiated one of the most comprehensive energy development and conservation programs in the region (ADB 1982, 1987), helping to reduce dependence on imported oil to only 50% by 1985. After three years of political and economic unrest, Marcos was driven from power in 1986 and replaced with Corazon Aquino. Under Aquino there was a return of moderate economic growth which, combined with sharply lower world oil prices, led to a reversal of trends in the Philippine energy sector. Commercial energy demand increased rapidly, and by 1992 dependence on imported oil had risen again to over 70%.

While oil import dependency continues to be a major energy policy issue in the Philippines, the primary concern in the energy sector today is with an electric power crisis that has stifled economic growth and hampered government efforts to attract foreign investment. The new administration of Fidel Ramos has made a resolution of this crisis one of its top domestic priorities, and is aggressively pursuing a private power development program that has already added over 1,000 MW of additional capacity to the power system in the last two years. In addition, Ramos was recently granted emergency powers to expedite approval and implementation of electric power projects. The extent to which Ramos succeeds in resolving the electric power crisis will in large part determine whether the Philippines can reverse its economic misfortunes of the last ten years, or continue to stand out as an economic debacle in one of the most dynamic growth regions of the world.

This paper reviews the energy policy experience of the Philippines since 1973, and analyzes projections of energy production and use into the next century. The following two sections discuss major developments in the Philippine energy sector during the Marcos (1973-1985) and Aquino (1986-1992) administrations. The energy plan of the Ramos administration and projections of energy supply and demand to the year 2000 are then presented.

A concluding section summarizes the major points of the paper, focusing on the policy lessons learned from experience in the Philippine energy sector over the last twenty years.

Energy Policy Under Marcos: 1973-1985

Energy-Economy Interactions

The global oil crisis of 1973 had immediate and unmistakable impacts on the Philippine economy, slowing growth, spurring inflation, and translating a $307 million trade surplus in 1973 into a $497 million deficit by 1974 (Table 1.1). The detrimental impact of the 1973 oil price shock was offset in part by increased foreign borrowing and strong performance in the export sector, including a 47% increase in the value of exports between 1973 and 1974 alone. Economic conditions in the Philippines were far less favorable when world oil prices increased again in 1979-80. Despite reductions in the actual volume of oil imports after 1978, the increase in world crude prices in 1980 served to double again the nation's oil import bill (Table 1.1). The Philippines' terms of trade, a ratio of the price index of exports divided by the price index of imports, deteriorated sharply between 1979 and 1982. Meanwhile, global recession stifled growth in the export sector, forcing Marcos to increase foreign borrowing even further, doubling the external debt to over $20 billion in just three years (Table 1.1). The economic impact of these developments on consumers and industry was compounded by devaluations in the Philippine

Peso from 1982 to 1984. Economic growth slowed to less than 4% in 1981 and 1982, and dropped to 1.8% in 1983 before political turmoil resulted in a -7.3% rate for 1984 and 1985 (Table 1.1).

Faced in 1973 with a soaring oil import bill and the prospect of supply disruptions, the Marcos government moved to ensure adequate supplies of oil for the immediate future, while simultaneously launching a long-term energy development and conservation program intended to reduce dependence on imported oil to 50% within ten years. The Philippine National Oil Company (PNOC) was established in order to facilitate government-to-government purchase agreements and diversify the country's crude oil sources since, at that time, 96% of supplies were originating from the volatile Middle East. Energy prices were increased to reflect changes in world oil markets and encourage conservation. And financial and technical resources were channeled into programs to promote both energy conservation and the development and utilization of indigenous coal, oil, hydro, geothermal and biomass resources (ADB 1987; Hoffman 1988; Lim 1989).

The aggregate impact of the Marcos energy program can be gauged by referring to Table 1.2 and Figures 1.1 and 1.2. By 1985, indigenous energy sources were meeting 45% of domestic demand, potentially displacing over 40 million barrels of oil imports a year (Table 1.2, Figure 1.1). Higher energy prices and other conservation measures combined to lower the *overall* energy intensity of the Philippine economy 10% between 1978 and 1985 (Figure 1.2). Fuel-switching away from oil in the electric power and industrial sectors led to even sharper declines in the *oil* intensity of the economy, which dropped 40% in the 1978-85 period. While declines in energy and oil intensities were also achieved in other Asian oil-importing developing nations during this period, conservation and fuel-switching gains in the Philippines appear particularly impressive by comparison (Sathaye *et al.* 1987; ADB 1987; Ang 1990; Imran and Barnes 1990; McRae 1992).

Progress in the Philippine energy sector during this period did not come without cost to the economy, nor were the policies pursued necessarily based on any concept of least-cost planning. Energy sector investments accounted for 30 to 40% of all public sector investment by the early-1980s (Munasinghe and Saunders 1988), with the electric power sector alone receiving over one-fourth of all World Bank loans and development assistance provided the Philippines (Jones *et al.* 1988). High energy prices were clearly important in promoting energy conservation and efficiency improvements, but some analysts speculate that prices may have been too high, stifling economic growth, reducing the competitiveness of the export sector, and resulting in a distortionary allocation of domestic resources

(Habito and Intal 1988; Siddayao 1988; Boyd and Uri 1993). Differential pricing of petroleum products in the name of equity led to a radical shift in product demand, creating refinery balance problems and the need for supplemental product imports, especially for diesel (Sathaye and Meyers 1986). Mandatory use of domestic coal in the power sector and some industries encouraged the development and expansion of an otherwise uncompetitive domestic coal industry (Hoffman 1988; Razavi 1991). Progress and problems in each of the various energy sub-sectors is discussed below.

Indigenous Energy Development

In 1973, domestic commercial energy production in the Philippines was limited to 5.6 million barrels of oil equivalent (boe), 8% of total demand (Table 1.2). The only domestic commercial energy source of any significance at the time was hydroelectric power generation. Over the next twelve years, domestic commercial energy production would increase 650%, new energy industries would be formed, and the Philippines would establish itself as a world-class producer of geothermal power, second only to the United States in electricity production from this resource.

The PNOC, created in 1973 to enhance the security of imported crude oil supplies, was soon given the additional mandate of promoting exploration and development of oil and gas resources in the country. In 1976, the first offshore oil discovery in the Philippines occurred off of Palawan Island (Figure 1.3), and by 1979 commercial production from the discovery was underway with the Nido field producing as much as 40,000 barrels per day (b/d) for a yearly production total of 8.6 million barrels. The Cadlao and Matinloc fields, also in offshore Palawan, began commercial production in 1981 and 1982, respectively. Both fields had smaller than expected yields, flowing only 3,000-4,000 b/d, and by 1982 production problems had reduced output from the Nido field to only 1,700 b/d. As a result, domestic oil production dropped from 8.6 million barrels in 1979 (9.2% of domestic demand) to 1.9 million barrels in 1981 (2% of demand), before stabilizing at around 3 to 4 million barrels per year from 1982-86 (around 5-6% of demand). Overall, oil exploration and production efforts of the period made only a minimal contribution to meeting domestic energy demand, although they did serve to pique interest in the long-term oil and gas potential of the Philippines and confirm its status as a marginally explored and developed area.

In 1976, Marcos promulgated the Coal Development Act in order to hasten exploration and development of indigenous coal resources, which were recently estimated to be as high as 1.5 billion metric tons of potential reserves (OEA 1992). The National Coal Authority (NCA) was created in 1980 to facilitate purchase agreements between domestic coal producers and potential consumers, guarantee markets and prices for domestic producers, and develop the necessary logistics and infrastructure needed for increased coal use and fuel-switching in the Philippine economy. Between 1981 and 1982, coal production expanded 69% in order to keep up with increased demand in the industrial sector, most notably for cement manufacture. In the next year, production increased by another 83%, largely in anticipation of the start-up of the 300-MW Calaca coal-fired power plant in Luzon. Marcos' efforts to boost domestic coal production and utilization increased the contribution of this fuel to the commercial energy mix from 0.2% in 1973 to 4.8% in 1985 (Table 1.2), with nearly all of this increased usage being accounted for by the electric power sector and cement industry. Despite this increase, the coal development program fell far short of expectations, with production and utilization reaching only around 60% of projected levels by the mid-1980s. This created the need for supplemental coal imports, mainly from Australia (Berbano 1986). Quality problems with coal from the largest mine on Semirara Island (Figure 1.3) also forced the National Power Corporation (NPC) to resort to increased coal imports for blending with Semirara coal (Hoffman 1988). Therefore, while the Marcos coal program helped to facilitate the substitution of coal for imported oil in some economic sectors, by 1985 nearly half of the country's coal requirements were being met through imports rather than by domestic supplies (Table 1.2).

Between 1973 and 1985, installed generating capacity of hydroelectric plants in the Philippines increased 235%, from 642 to 2,147 MW, increasing the share of hydro energy in the overall commercial energy mix from 4.6% to 10.3% in the process (Table 1.2). Much of this expansion took place on the southern island of Mindanao (Figure 1.3) where, by 1985, 83% of the island's generating capacity was hydro-based. The low operating costs of the Mindanao grid enabled the NPC to price electricity on the island at one-half to one-third the rate charged in other areas (Sathaye 1987). Availability of cheap hydroelectric power encouraged electricity-intensive industries to locate in industrial zones of Mindanao during the 1960s and 70s. While a predominance of hydro-based capacity allowed for lower electric rates in Mindanao, it also exposed the island's economy to the vagaries of weather and water supply. In 1991, severe drought resulted in over a 50% curtailment in power supply for the island, creating substantial economic dislocation. At present, only around 24% of the nation's potential hydropower capacity is being harnessed. Distance of exploitable sites from demand centers and public opposition to dams have combined to hold back further development of this resource.

A major accomplishment of the Marcos energy development program was the establishment of the Philippines as the second largest producer of geothermal power in the world after the US, with 894 MW of geothermal capacity in place by 1985, meeting 9.2% of commercial energy demand (Table 1.2). Even at this level of production, however, only a fraction of the country's geothermal potential was actually being utilized. Several factors combined to limit more rapid development of geothermal resources, factors which have continued to hinder development until today. First, a number of major geothermal fields, such as Tongonan in Leyte and Palinpinon in Negros, are isolated from demand centers due to the absence of an interconnected electric grid between islands (Figure 1.3). Second, potential private sector developers of geothermal steam have been discouraged by provisions in the Geothermal Service Contract Law which place an effective 60% tax on net income from development, and put a price ceiling on geothermal steam lower than those derived from oil or coal. Third, the largest developer of geothermal steam in the country, the PNOC-Energy Development Corporation, and the largest consumer, the NPC (both government-owned), have failed to coordinate their respective investment decisions with regards to development of major geothermal fields. In one case the PNOC invested $800 million into exploration and development of the Tongonan geothermal field only to have it go unutilized because the NPC did not install the necessary power plant and transmission lines (Razavi 1991). Despite these obstacles, private and public sector interest in geothermal development in the Philippines remains strong, not only because of its status as an indigenous form of energy but also because it appears to be the least-cost alternative for power generation (Table 1.3). In addition, exploitation of geothermal resources is expected to increase in the future as a result of the gradual interconnection of major island grids in the country, as well as due to revisions in the geothermal law which should encourage greater private sector investment in this resource.

Notably, the single most important domestic energy source in the Philippines, biomass fuels, have received the least attention both in terms of supply assessment and actual development of potential. Recent estimates of biomass energy use in all sectors of the economy are on the order of 90 million boe annually, roughly equivalent to current levels of oil imports (DOE 1993). However, the "non-conventional" energy category in most official government energy reports (and listed in Table 1.2) only considers the use of bagasse (sugar mill wastes), agriwastes and wood wastes by large-scale industrial firms, ignoring the pervasive use of woodfuels and non-woody biomass fuels by households and small-scale commercial establishments throughout the country (Hyman 1984, 1985; DAP 1992; Bensel and Remedio 1993). Despite this limitation, Table 1.2 still shows that non-conventional energy accounted for anywhere from 13 to 18% of total domestic commercial energy consumption during Marcos' term. The Marcos energy program did include fiscal incentives for research, development and utilization of biomass fuels on commercial scales, and a National Alcohol Commission was created in 1980 to look into the feasibility of producing transport fuels from sugar cane and coconut oil (ADB 1987; Lim 1989). In addition, the Philippines pioneered development of wood-fired (dendrothermal) power generation, with original plans calling for establishment of over sixty 3-MW wood-fired plants in rural areas of the country to be fueled by trees grown as part of farm forestry projects (Denton 1983; Durst 1986a, 1986b, 1987; FAO 1987). These programs were all in early stages of development when, by the mid-1980s, political upheaval in the Philippines and low world oil prices combined to eliminate them. Industrial biomass fuel consumption for direct production of process heat remains high in the Philippines, although low world oil prices and a lack of official support have limited, for the time being, any serious consideration of programs to convert the country's substantial biomass resources into modern energy carriers such as electricity or liquid and gaseous fuels. Substantial uncertainty surrounding estimates of non-industrial biomass fuel consumption, as well as other factors, continue to keep this aspect of energy use in the Philippines out of official reports (Bensel and Remedio 1992). The most recent official energy plan continues the practice of including only large-scale industrial biomass fuel use in the non-conventional energy category (OEA 1992) .

In summary, the Marcos energy program helped to increase indigenous commercial energy production from 5.6 million boe in 1973 to 41.6 million boe in 1985, in the process reducing the nation's dependence on imported oil from 92% to slightly over 50%. With the exception of limited domestic oil production, the bulk of the progress made in the Philippine energy sector came through the exploitation and use of non-oil energy forms. The largest reductions in demand for oil were achieved in the power sector and a few oil-intensive industries such as cement where technical barriers to using alternative fuels were lowest (ADB 1987; Ang 1989, 1990). Oil substitution also occurred to a lesser extent in other industries and in the residential and commercial sectors due to a combination of government incentives and higher oil prices. Fuel-switching appears to have been responsible for approximately three-fourths of the decline in oil intensity experienced in the Philippine economy from 1973 to 1985, with energy efficiency improvements and conservation accounting for the remaining one-fourth. Further discussion of how oil displacement was achieved during this period is provided below.

Oil Displacement by Indigenous Energy Sources

In the Philippines, as in other Asian developing nations, the largest displacement of imported oil was achieved in the electric power industry (Ang 1990). Figure 1.4 illustrates that between 1973 and 1985, non-oil plants accounted for nearly all of the incremental power generation in the country, with the share of oil-fired plants in total power generation decreasing from

87% to 35% during this period. In order to estimate the volume of oil displaced in the electric power sector due to fuel substitution efforts, and the relative contribution of various non-oil energy sources to this trend, the following approach is used. Assume that in the absence of any fuel substitution effort, the *share* of oil in total energy use in the electric power sector would have remained the same as in the base year, 1973. This is represented by

$$S_{j,b} = O_{j,b} \,/\, E_{j,b} \qquad (1)$$

where $O_{j,b}$ is oil consumption in sector j (in this case the power sector) in the base year b, $E_{j,b}$ is total commercial energy consumption in that sector in year b, and $S_{j,b}$ is the share of oil in overall energy consumption in sector j for the base year. In the Philippines the figure for $S_{j,b}$ for the power sector was .746. Using equation (1), and figures for actual energy and oil use in the power sector for the years 1973-1985, we estimate oil displacement in this sector through the following formula.

$$D_{j,t} = E_{j,t}\,(S_{j,b}) - O_{j,t} \qquad (2)$$

$D_{j,t}$ is the volume of oil displaced through fuel substitution in sector j in year t, $E_{j,t}$ is total commercial energy consumption in sector j for year t, $S_{j,b}$ is the base year oil share for sector j, and $O_{j,t}$ is actual oil consumption in sector j for year t. Table 1.4 presents estimates of oil displacement in the power sector for the years 1973-1985 using equation (2). Column 5 shows total oil displacement from fuel-switching in the power sector for each year, with positive values indicating oil savings and negative values actual increases in oil use over what would have occurred had $S_{j,b}$ remained constant. Overall, fuel substitution in the power sector displaced approximately 41.9 million boe over the 1973-85 period. By comparison, oil imports in 1985 were 47 million boe.

No substantial oil displacement took place in the power sector until 1980 when hydroelectric generation increased 23% and power from geothermal plants increased 225% (Figure 1.4). The largest displacement occurred in 1984 and 1985 due to a doubling of hydroelectric and coal-fired generation in 1984, a tripling of coal-fired generation in 1985, and regular increases in power supply from geothermal plants in each of those years. In order to estimate the *relative* contribution of each fuel to total oil displacement in the power sector, the following approach is used.

$$C_{i,t} = [G_{i,t} - (S_{i,b})(T_t)] / R_t \qquad (3)$$

$C_{i,t}$ represents the percentage contribution of fuel i to overall oil displacement in the power sector in year t. $G_{i,t}$ is total power generation from fuel i in year t. $S_{i,b}$ is the percentage share of fuel i in the power generation mix in the base year, 1973. T_t is total power generation for year t from all fuels. And R_t is the overall reduction in oil-fired generation in year t due to oil displacement, which is determined by

$$R_t = T_t\,(G_{o,b} / T_b) - G_{o,t} \tag{4}$$

where $G_{o,b}$ is power generation from oil-fired plants in 1973, T_b is total power generation in that year, and $G_{o,t}$ is actual oil-fired power generation in year t. Table 1.5 provides a breakdown of the contribution of each fuel to oil displacement in the power sector for the years 1980-85. Overall, the addition of close to 900 MW of geothermal capacity between 1979 and 1984 had the biggest impact, displacing 25.5 million boe, or 57.4% of total displacement in the 1980-85 period. The contribution of hydroelectric to this trend was limited by a drought-induced 21% reduction in hydro generation in 1983. Even still, the addition of 1,021 MW of new hydro capacity between 1980 and 1985 helped to displace 11.6 million boe in that period, 26.1% of the total. Coal-fired generation made only minor contributions to oil displacement until 1984, when the 300-MW Calaca plant was brought on-line. By 1985, the Calaca plant in Luzon and the 50-MW coal-fired plant in Naga, Cebu, were helping to displace 4.6 million boe/year in the power sector (Table 1.5).

The Marcos administration planned to make the electric power sector even more diversified in the long-run through the introduction of nuclear power plants into the generating mix. Initially, plans for as many as eleven nuclear plants were being developed to meet power demand in Luzon, which by the late-70s was growing at rates of 5 to 10% a year (Bello *et al*. 1983). Construction of the first nuclear plant in the country, a 620-MW

Westinghouse light-water reactor known as the Bataan Nuclear Power Plant (BNPP), began in 1977 with an estimated construction cost of $840 million. Over the next eight years, the BNPP project would be plagued by cost overruns, public opposition, allegations that Westinghouse bribed top government officials to obtain the contract, and concern over shoddy construction and location of the plant in an active seismic zone (Gray 1989). The final construction cost of the BNPP exceeded $2 billion, and soon after ousting Marcos in 1986 the Aquino administration abandoned the plant and began pursuing a legal case against Westinghouse which is still being waged in U.S. courts to this day. This experience, and a strong anti-nuclear clause in the new constitution of 1986, have eliminated any serious discussion of further nuclear power development in the Philippines for the foreseeable future.

Besides electric power, oil displacement also took place to a lesser extent in the industrial and residential/service sectors of the Philippine economy. In industry, cement manufacturers were targeted for fuel-switching in an effort to reduce their oil use and to serve as a model for other industries. The government essentially mandated that all cement plants switch to coal, and sweetened the mandate with an attractive package of technical and financial assistance that included duty-free importation of the necessary equipment, low-interest loans for equipment purchase, and favorable prices for domestic coal (Berbano 1986; ADB 1987). As a result, demand for coal in the cement industry jumped from 143,000 tons in 1981 to 803,000 tons in 1984. The extent of fuel-switching in other industries besides cement is less well-documented, but there is evidence that a combination of high domestic oil prices and government investment incentives induced substantial moves away from oil (MOE 1984; ADB 1987). For example, between 1979 and 1981 fuel oil consumption in the paper industry declined 49% (or 724 thousand boe), while consumption of wood wastes increased 44% (or 303 thousand boe). Fuel-switching from oil to biomass also appears to have taken place to a lesser extent in the tobacco, wood products, and coconut/vegetable oil industries. With the exception of fuelwood use in the tobacco industry, most industrial biomass fuel consumption took the form of agricultural residues and wood wastes, and therefore probably had little or no impact on deforestation trends in the country. Overall, oil's share in industrial energy consumption dropped from 89% in 1973 to 69% in 1985, with the difference being made up for through the substitution of coal, electricity and biomass fuels. Using equation (2) we estimate the amount of oil displacement in the industrial sector from 1973 to 1985 due to fuel substitution efforts (Table 1.6). Given the absence of regular data on biomass fuel use in the industrial sector, the contribution of this fuel is excluded from the analysis. Likewise, since oil displacement was already measured for the electric power sector, we discuss only the substitution of coal for oil in the industrial sector, ignoring the substitution of electricity for oil in the industrial sector. Between 1973 and 1985 increased coal use in the industrial sector reduced oil consumption by 9.45 million boe (Table 1.6). Most of this substitution took place after 1983 as a result of a 365% increase in coal use in the cement industry from 1982 to 1984, and a near total switch to coal by the Atlas Copper Mine in Cebu in 1983 (Hoffman 1988).

In the residential sector, higher prices for kerosene and LPG cooking fuels induced many households, both rural and urban, to scale back on their consumption of these fuels and increase their use of woodfuels and non-woody biomass (MOE 1982, 1984). Prices for kerosene and LPG increased more than five-fold in the Philippines between 1978 and 1984. During the same period, petroleum product consumption in the residential sector declined 30%. This decline took place in spite of the fact that during those years the population had grown from 46.2 million to 53.4 million, with the urban population growing at an even faster pace. By contrast, electricity consumption in the residential sector grew steadily throughout the Marcos era, increasing an average of 11.5% a year over the 1973-85 period. This trend was due to a combination of increased ownership and use of electric appliances (mainly in urban areas), relatively lower power rates for residential sector users, and expansion of electrical coverage in rural areas due to an aggressive government electrification campaign (Sathaye 1987).

Determining the volume of oil displaced in the residential sector due to substitution of biomass fuels is made difficult by the absence of regular data on household woodfuel use, although oil savings in this sector were relatively minor compared with that achieved in the electric power and industrial sectors. An order of magnitude estimate for the 1973-85 period based on an extrapolation of data from available years would indicate that increased biomass fuel use in the residential sector displaced 4.2 million boe, or less than half of industrial oil displacement and one-tenth of electric power sector displacement (Tables 1.6 and 1.4).

Over the 1973-85 period, the substitution of imported coal and indigenous biomass, coal, hydro and geothermal energy helped to displace approximately 55.6 million boe of potential oil imports in the Philippine economy, 20% more than total oil imports by the country in 1985. Fuel substitution in the electric power sector accounted for 75% of total oil displacement, with substitution in the industrial and residential sectors accounting for 17% and 8% of the total, respectively. In addition to fuel substitution, oil imports were held down during the Marcos years through an energy conservation/efficiency campaign discussed in the next section.

Energy Conservation and Pricing Policy

Comparative studies of energy policies in Asian developing nations during the past twenty years indicate that among this group the Philippines initiated one of the most comprehensive energy conservation programs in the region (ADB 1982; Sathaye *et al*. 1987; ADB 1987; Siddayao 1988). A variety of direct and indirect policy approaches were employed in an effort to eliminate wasteful use of energy and improve the efficiency of energy use in the transport and industrial sectors. One indication of the impact this program had on energy consumption can be gauged by referring to Table 1.7, which presents the energy and oil intensities of nine Asian economies for the years 1973, 1979 and 1985. In 1973, the Philippines had the fifth highest energy intensity, and second highest oil intensity of the nine. Energy and oil intensities in the Philippines were somewhat higher than those for Indonesia, Malaysia and Thailand, other ASEAN countries with economies and industrial sectors most similar to that in the Philippines. By 1985, however, energy and oil intensities in the Philippine economy were ranked eighth and seventh, respectively, and were substantially lower than those for the other ASEAN countries listed. The Philippines and Thailand managed the most significant reductions in oil intensities, an indication of the high dependence on oil of these countries in 1973 as well as the aggressive oil displacement programs pursued by their respective governments. While fuel substitution accounted for much of the reduction in the *oil* intensity of the Philippine economy during this period, it was conservation programs and efficiency improvements that were in large part responsible for reducing the overall *energy* intensity of the economy by 2.2% per year (Table 1.7).

A combination of high energy prices and direct policy initiatives were used by the Marcos government to control energy consumption in the Philippine economy. An energy demand management program was formally legislated in 1975, which included an energy conservation information campaign in the media, financial incentives and tax concessions for the installation of energy efficient equipment, mandatory audits and energy conservation targets for larger industries, training of industry personnel in conservation techniques, mandatory labelling of some equipment, appliances and vehicles to show energy requirements, duty-free importation of equipment to be used to facilitate fuel-switching or efficiency improvements, mandatory efficiency standards for new buildings, and restrictions on the production and/or importation of fuel-inefficient vehicles (ADB 1987). The effectiveness of these efforts was enhanced by the energy pricing policy of the government which kept domestic oil prices anywhere from 5 to 37% higher than the regional average during the 1973-85 period (Figure 1.5).

While energy pricing policy was originally adopted as a means to control energy consumption, it was later used to try and achieve additional objectives such as government revenue generation, energy price stability, social equity, and domestic energy development. By the early-1980s, taxes on petroleum products were providing up to one-fourth of all government tax revenue (Habito and Intal 1988). A portion of the revenue generated from oil taxes was earmarked for development of domestic energy sources, including coal, hydroelectric and geothermal projects. Imported coal was slapped with a 20-30% tariff in order to help maintain the competitiveness of domestic producers. Differential pricing of petroleum products was adopted on equity grounds, with cross-price subsidization of "social" fuels such as kerosene and LPG — used by urban households for cooking — and diesel, which was widely used in public transport. Finally, an effort was made to develop a mechanism which would help stabilize oil prices in the event of abrupt changes in world oil markets and/or the foreign exchange rate of the Philippine Peso. The Crude Cost Equalization Fund and, later, the Oil Price Stabilization Fund (OPSF) were established for this purpose. The OPSF worked by setting a reference price for imported oil, if the actual price for oil fell below the reference rate then oil companies were required to remit their savings to the OPSF. In turn, if import costs were higher than the reference rate the OPSF would reimburse the difference to the oil companies.

The government energy conservation program and pricing policy combined to improve the intensities of energy use in a number of areas of the economy, notably the industrial and transportation sectors (Table 1.8). In the industrial sector, energy intensity declined an average of 5.8% a year between

1978 and 1984, with some of the most significant improvements in the efficiency of energy use occurring in the sheet metal, textiles, rubber and chemical industries. From 1973 to 1985, overall commercial energy use in the industrial sector declined 11%, from 27 to 24 million boe, despite the fact that value added in this sector increased (in *real* terms) by close to 60% over the same period (MOE 1982, 1984; Sathaye *et al*. 1987). Reductions in energy and oil intensities in the industrial sector appear *not* to have resulted from any fundamental shift towards less energy- or oil-intensive industries, since the composition of the industrial sector changed little during this period (NSCB 1993). The fuel intensity of the transport fleet declined from 3 toe/vehicle/year in 1978 to 2.1 in 1984 (Table 1.8), with this due mainly to a combination of less driving, improvements in vehicle stock, and a shift to diesel engines in the jeepney fleet in response to substantially lower prices for this fuel relative to gasoline. Finally, the energy intensity of the residential/service sector also declined over this period, from 24.5 toe/1,000 persons/year in 1978 to 18.5 in 1984 (Table 1.8). This last trend occurred in spite of increased urbanization in the country, a factor which usually increases residential/service sector energy intensity (D.W. Jones 1989).

In order to estimate the amount of energy saved in the Philippines through energy conservation and efficiency improvements, the following approach is used. Given that energy intensity figures are based on energy consumption per unit of economic output, and that no major structural changes occurred in the composition of economic output in the Philippines over the period being discussed, declines in energy intensity of the economy are assumed to reflect actual improvements in the efficiency of energy use achieved either through the introduction and use of more energy efficient equipment, or through behavioral changes in energy use. Therefore, energy savings from efficiency in year t can be measured by

$$F_t = N_b\,(GDP_t) - Y_t \tag{5}$$

where N_b represents the energy intensity of the economy in the base year (1973), GDP_t the gross domestic product (in real terms) for year t, and Y_t the actual level of commercial energy consumption in year t. Energy savings for the 1973-85 period are estimated at 80.8 million boe (Table 1.9), or around 87% of the commercial energy consumed in the country in 1985. Most of the energy savings were achieved after 1979, a pattern consistent with that experienced in other Asian developing nations where a lag of six to eight years (after the 1973 oil crisis) was observed before increases in energy prices and other factors had any noticeable impact on intensities of energy use (ADB 1987; Siddayao 1988; Ang 1990). Some of the energy savings in the Philippines can be explained by a switch from commercial to non-commercial energy like fuelwood and other forms of biomass since consumption of these fuels has been excluded from the calculations. Nevertheless, direct and indirect policy approaches intended to promote energy conservation clearly did have an impact on levels of energy demand in the Philippines during the Marcos era. From 1973-1985, overall commercial energy use in the Philippines increased only 32.6%, while oil use actually dropped 23%. This occurred despite the fact that over the same period the economy grew 46%, the overall population increased 37%, and the share of the population residing in urban areas, where energy use per capita is typically higher than average, went from 34 to 40%.

Assessment of the Marcos Energy Program

Figure 1.6 contrasts actual levels of energy and oil consumption in the Philippines from 1973-85 with what would have occurred had the energy intensity of the economy, and the share of oil in the energy mix, remained at 1973 levels. The difference between actual energy use and hypothetical (base-case) energy use represents savings achieved through reductions in the energy intensity of the economy, much of which can be attributed to more efficient energy use and conservation efforts. The difference between actual and base-case oil use represents oil savings achieved through a combination of efficiency/ conservation and the substitution of non-oil energy sources for oil, especially in the electric power and industrial sectors.

In order to separate out the relative contribution of efficiency/ conservation versus fuel substitution in reducing oil consumption in the Philippines during the period under study, the following approach will be used. Had the energy intensity and oil share remained at 1973 levels, then oil consumption would be equivalent to the line labelled "base-case oil use" in Figure 1.6, represented by

$$H_t = [N_b\ (GDP_t)]\ (O_b) \tag{6}$$

where H_t is hypothetical (base-case) oil use in year t, N_b is the energy intensity of the economy in the base year (1973), GDP_t is gross domestic product in year t, and O_b is the share of oil in the energy mix in 1973. Had oil's share in the energy mix remained at 1973 levels, then we can determine approximate oil savings from efficiency improvements alone by comparing H_t with C_t where

$$C_t = E_t\ (O_b). \tag{7}$$

C_t is oil consumption in year t that would have occurred had oil's share in the fuel mix remained constant but the energy intensity of the economy was allowed to fluctuate. E_t is actual energy consumption in year t. Finally, reductions in oil use due to substitution in year t is determined by the difference between C_t and A_t, where A_t represents actual oil consumption in year t. Therefore,

$$F_t = H_t - C_t \tag{8}$$

$$W_t = C_t - A_t \tag{9}$$

$$T_t = (8) + (9) = F_t + W_t \tag{10}$$

where F_t represents oil saved in year t due to energy efficiency and conservation practices, W_t represents oil saved due to fuel switching efforts, and T_t represents overall oil savings due to the combination of these two trends.

Figure 1.7 presents the results of this exercise for the years 1973-85, illustrating that over that period the substitution of non-oil energy sources in different sectors of the economy accounted for approximately three-fourths of the reduction in oil use over base-case levels. Figure 1.7 also shows that in the five years immediately following the 1973 oil crisis, the only substantial reductions in oil use occurred as a result of fuel substitution, but that over the longer term conservation and efficiency improvements began to play a larger role. Overall, the combined impact of energy conservation, efficiency improvements and fuel substitution in the Philippine economy from 1973-85 was a cumulative reduction in potential oil consumption of close to 280 million boe. Using the estimate of T_t for each of these years multiplied by average prices for imported crude in those years, we estimate a potential cumulative foreign exchange savings to the Philippine economy of $7.2 billion during the period under study, or a 38% reduction in the oil import bill over what would have occurred if no oil savings were achieved.

While the potential foreign exchange savings from oil displacement appear impressive, they should be compared with the costs incurred by the government, and the economy as a whole, in order to bring them about.

Determining these costs in a precise manner is beyond the scope of this paper, and would require highly disaggregated public finance and investment data. However, it's been estimated that by the early-80s, as much as 40% of total public sector investment in the Philippines was going into the energy sector (OTA 1992). Furthermore, energy sector investments tended to have a very high foreign exchange component, implying that some percentage of the foreign exchange savings from reduced oil consumption was needed to import the equipment and material necessary to develop domestic energy resources (ADB 1982). In addition to the direct investment costs, consideration should also be given to the possibility of indirect economic costs imposed on the country as a result of distortionary impacts of energy policy. For example, the stated objectives of energy pricing policy were to encourage efficiency, promote development of indigenous resources, achieve price stability, and accomplish social equity objectives through differential pricing of energy forms based on their relative use by richer or poorer consuming sectors. However, these objectives were rarely compatible, and a case could be made that they were all secondary to the more important (albeit unstated) objective of energy pricing policy: government revenue generation. From 1980-85, taxes on petroleum products alone represented 24% of all government tax revenue, totalling close to $1 billion a year on average (Habito and Intal 1988; Hoffman 1988; ADB 1990). Using a computable general equilibrium model of the Philippine economy, Boyd and Uri (1993) attempt to determine the impact of a complete elimination of taxes on refined petroleum products for the year 1983. They estimate that removing taxes would have resulted in a 3.7% increase in output of all economic sectors, a 13.6% increase in the consumption of goods and services, and an increase in total utility of 14.3%. Offsetting these gains is a substantial reduction in government tax revenue, although the limitations of the model preclude a direct comparison of this loss with the benefits mentioned above.

The government objective of achieving 50% energy self-reliance also justified programs and policies that would not have withstood objective economic scrutiny. Despite quality problems and low productivity, the domestic coal industry was promoted through the imposition of a 30% tariff on imported supplies and a requirement that consumers purchase at least half of their coal from domestic producers (Hoffman 1988). In later years, protection of the coal industry was justified on the basis of the fact that it was a substantial source of employment (Berbano 1986). A national alcohol fuel program was launched to develop a gasoline/alcohol blend with alcohol produced primarily from sugarcane. This program was once again justified largely on the basis of the need to reduce dependence on imported oil, although it's evident that the powerful sugar lobby was instrumental in pushing for this program (Habito and Intal 1988). Some energy projects, such as the nuclear plant, appear to have been undertaken in large part to "showcase" the Philippines as a modern and progressive developing nation, rather than to provide an economical source of energy. Even if this plant had been built on schedule and at cost, average generating costs would still have been substantially higher than other power generation alternatives available to the Philippines at the time (Razavi 1991).

Over the 1973-1985 period, close to one-hundred laws were proposed and passed in the Philippines directly relating to the energy sector, and the government became the dominant force in all facets of energy production, distribution and pricing (Paderanga and Paderanga 1988). Billions of dollars, much of it borrowed, was spent on domestic energy development and power projects. The benefits of these policies and investments, in terms of reducing dependence on imported oil, were made clear in the discussion above. But by 1983, rapidly changing economic and political conditions in the Philippines were overshadowing any concern for the energy sector. The political turmoil and uncertainty created by the assassination of Senator Benigno Aquino in August of that year was enough to bring the economy to a standstill and induce massive capital flight out of the country. Subsequent devaluations of the Peso offset any potential relief provided by declines in world crude oil prices after 1982, resulting in continually high trade deficits and foreign borrowing. In 1984 and 1985 the Philippine economy suffered back-to-back declines in GDP of 7.3%, furthering discontent and contributing to the overthrow of Marcos in February 1986 and his replacement with the widow of the slain Senator Aquino.

Energy Policy Under Aquino: 1986-1992

Energy-Economy Interactions

With the change in administration in the Philippines in 1986 came a return of political stability and investor confidence in the economy. After three consecutive years of declining GDP, the economy grew at annual rates of from 3.5 to 6.8% between 1986 and 1989. Figures 1.8a-d plot changes in economic performance from 1980-92 relative to commercial energy consumption, oil imports and electric power consumption (see also Table 1.1). Increases in commercial energy consumption out-paced economic growth throughout Aquino's term (Figures 1.8a and b). Oil imports, after declining for six straight years, grew at rates of from 3 to 19% a year in the 1986-92 period (Figure 1.8c). Electric power consumption grew at an average annual rate of close to 10% in the late-80s, until capacity could no longer keep up and a power crisis set in around 1990 (Figure 1.8d). Increased demand for energy in general, and oil in particular, was spurred on by economic recovery and substantial reductions in international and domestic petroleum prices. Average petroleum product prices declined nearly 40% in the late-80s, with prices for diesel, fuel oil and LPG experiencing even sharper declines (Harris 1989). After dropping as low as 51% in 1985, the share of imported oil in the commercial energy mix rose again to 64% in 1991 and 70% by 1992 (Table 1.2). Declining oil prices also contributed to a reversal in energy efficiency and fuel substitution trends in the Philippines, resulting in increases in both the energy and oil intensities of the economy (Figure 1.2).

Oil consumption increased most rapidly in the transportation, residential/service, and electric power sectors (Figure 1.9). Oil use in the transport sector nearly doubled between 1985 and 1990, increasing over 20% a year in 1989 and 1990 alone. By comparison, the number of motor vehicles registered in the country increased only 44.6% over the entire 1985-90 period, suggesting an increase in the oil intensity of the vehicle fleet and a reversal of trends in transport oil intensities reported for the 1978-84 period (Table 1.8). Petroleum product consumption in the residential/service sector grew at an average rate of 22% a year between 1986 and 1990. Lower prices for petroleum products, a 10% increase in national population, a 20% increase in the urban population, and rising per capita incomes contributed to this increase. Residential sector fuel-switching trends also appear to have played a role, with the percentage of households nationwide using LPG as their primary cooking fuel increasing from 12 to 21% between 1980 and 1989 (DAP 1992). In the electric power sector, oil-fired generation increased 80% between 1986 and 1992, with the share of oil-fired plants in the total generating mix growing from 36% to 53% during the period (Figure 1.10). Growth in oil-fired generation was made necessary by sharp increases in power demand in the late-80s, a 35% reduction in hydroelectric generation from 1989 to 1992 due to drought, and a 23% reduction in coal-fired generation over the same period due to a string of plant breakdowns and natural disasters. Oil consumption in the electric power industry went from 9 million boe in 1986 to 15.9 million boe in 1990. After stabilizing in 1991, power sector oil use grew another 68% in 1992 alone, rising to 28.4 million boe in that year.

Rapid growth in demand for petroleum products pushed oil imports up 86% between 1986 and 1992, resulting in a 139% increase in the nation's oil import bill over that period. While rising oil imports were of concern to Aquino's energy managers, the larger problem in the Philippine energy sector at the time was a nationwide power crisis serious enough to force most portions of the country to go without power for 6-15 hours every day. The power crisis has been blamed for the poor performance of the economy since 1990, with estimates of lost economic output as a result of power shortages ranging up to 6% of GDP a year. This situation prompted calls for the government to declare a state of calamity and assume emergency powers in order to rectify the problem.

Origins and Impacts of the Power Crisis

Most observers in the Philippines attribute the power crisis to incompetence, poor planning and mismanagement on the part of the Aquino administration in general, and the NPC in particular. In reality, a combination of factors, many beyond the control of Aquino or the NPC, appear to have led to the problem. To begin with, between 1987 and 1990 demand for electric power was growing at an average rate of around 7% a year, while the growth in installed generating capacity averaged only 1.5% a year. Failure to add capacity is due in part to the fact that soon after assuming office in 1986 Aquino abolished the corruption-tainted Ministry of Energy, which had earlier assumed a critical coordinating and planning role in all aspects of the energy sector, including electric power. In addition, Aquino cancelled funding for a series of power projects begun by Marcos with a combined generating capacity of over 1,000 MW, including the 620-MW nuclear plant and six other non-nuclear projects.

While these decisions certainly contributed to the eventual shortage of electric power in the Philippines, they should be placed in the proper political and economic context before criticizing the Aquino government. For example, there is evidence that as early as 1974 NPC officials were recommending against the contract with Westinghouse for construction of the BNPP since competing American and European firms were submitting bids to build plants with larger capacities and at lower cost than that proposed by Westinghouse (Gray 1989). Despite this, Marcos pressured the NPC to award the contract to Westinghouse, presumably for reasons of self-enrichment, with the original construction cost negotiated at $650 million. By the time Aquino came to power, construction costs of the BNPP had risen to over $2 billion, and the Philippines was already paying over $300,000 *per day* in interest payments on loans for that plant alone. Aquino's decision not to operate the BNPP was strengthened by concerns over shoddy construction and its location in an active fault zone, as well as by a report prepared by a U.S. nuclear consultancy firm which concluded that repair, upgrading and operation of the plant would be highly uneconomical and even dangerous (Caruncho 1992). Investments in the BNPP, and subsequent payments on the outstanding portion of the BNPP loans, ate up a large portion of the power sector development budget for the period. At a broader macroeconomic level, Aquino inherited from Marcos close to $30 billion in external debt, and associated economic stabilization programs imposed by the IMF which limited government investment in the power sector and other areas of the economy (Razavi 1991; Cruz and Repetto 1992).

In addition to the nuclear fiasco, developments in the geothermal and hydroelectric sectors, and problems with coal-fired plants, also contributed to electrical power shortages during Aquino's term. By the mid-80s, *proven* steam capacity of geothermal fields in the Philippines stood at around 1,500 MW, compared with installed capacity of less than 900 MW. Isolation of the largest geothermal fields from major population and industrial centers due to the absence of an interconnected grid, and provisions in the geothermal service law which discouraged further development of this resource, resulted in no expansion of installed geothermal capacity after 1984. A serious drought beginning in 1989 adversely affected the operation of hydroelectric plants, which at the time represented one-third of installed generating capacity. As a result, hydroelectric power generation declined 6.5% in 1990, 15.1% in 1991, and 17% in 1992 (Figure 1.10). Finally, power supply from coal-fired plants dropped 20% in 1990 due to a series of plant breakdowns and typhoon damage to the Naga plant in Cebu.

Estimates of unserved power demand in the Philippines went from 5.5 million kilowatt-hours (mkWh) in 1988 to 406 mkWh in 1990 and 1,269 mkWh in the first six months of 1992 alone. Daily power outages of six to twelve hours hit Manila and the rest of Luzon throughout 1991 and 1992, while drought crippled the largely hydro-based (86% of capacity) power system of Mindanao, resulting in daily outages of twelve- to sixteen-hours throughout that island. During this period, the industrial sector turned increasingly to self-generation of electricity in order to meet their power needs. Petroleum product consumption in the industrial sector as a whole increased 26% in the first four months of 1992 due in large part to the need for fuel to run generators. Commercial sector demand for diesel-fired electrical generator sets also increased in 1991 and 1992, prompting the government to lift tariffs on the importation of these units. No reliable data exist on the magnitude of self-generated electricity in the country, but the combined effect of increased reliance on oil-fired capacity in the power sector, industrial self-generation, and commercial sector use of diesel generators can be gauged by the dramatic increase in demand for petroleum product imports during this period. Fuel oil and diesel imports increased 88% and 155%, respectively, in the first four months of 1992.

The electric power crisis has clearly had an impact on economic activity in the Philippines, although estimating actual losses to the economy is difficult. Recent studies of the economic impact of power outages in developing countries show that depending on the assumptions made, economic sectors included in the analysis, and the specifics of the power situation in each country, outage costs can range from US$.25 to $12 per kWh of unmet demand (Jones *et al*. 1988; Jhirad 1990; Sanghvi 1991). Table 1.10 presents estimates of the economic impact of the power crisis in the Philippines for the years 1990-1992 using three different estimates of the per kWh cost of unmet demand. Case 1 uses an estimate of ¢30/ kWh which was developed by NPC economists in 1985 to represent financial losses resulting from idle time, foregone output, spoiled raw materials and damaged products in the industrial sector (IBON 1990). Case 2 uses an estimate of ¢60/kWh which was recently adopted by the National Economic and Development Authority (NEDA) to estimate the economy-wide impact of the power crisis (Arroyo 1992). Case 3 uses a revised NPC estimate of $1.20/kWh which was computed by dividing GDP by electricity consumption to determine the economic value of electric power services (IBON 1990). To put these figures in perspective, the per kWh cost estimates in Table 1.10 can be compared with the typical utility costs for power generation of ¢5-10/kWh, and the cost of self-generation in industry, commercial establishments and households of ¢20-75/kWh (Jhirad 1990; Schramm 1990).

The figures in Table 1.10 suggest that since 1990, the power crisis in the Philippines has reduced potential GDP by anywhere from 0.3 to 5.8%. It should also be mentioned that as computed, the per kWh costs of unmet power demand used in Table 1.10 come closer to estimating the direct *financial* costs of power shortages to industrial firms rather than the overall *economic* costs of these shortages to society as a whole (Munasinghe 1979). Costs to households and individuals could include loss of utility, spoilage of foodstuffs due to lack of refrigeration, damage to electric appliances from sudden changes in voltage, inconvenience and time wasted in traffic caused by traffic light failures, and, in some cases, replacement costs of utility-supplied electricity through the operation of individual generator sets. The difference between self-generation costs of ¢20-75/kWh, and the average consumer price for grid supplied electricity in the Philippines of ¢8/kWh, is said to indicate both the willingness-to-pay of consumers for reliable electric supply as well as some of the economic costs to society of inadequate supply (Schramm 1990). An additional element not incorporated into the cost estimates is the potential impact the power crisis has had on investor confidence in the Philippine economy. Though difficult, if not impossible to measure, officials in the Philippines have acknowledged that one of the greatest hindrances to attracting foreign investment in the economy is investor concern over inadequate and unreliable power supply.

Recognizing the need for power system expansion to meet growing demand, and cognizant of NPC estimates of capital requirements of $1 billion/year to achieve this expansion, Aquino signed Executive Order (EO) 215 in 1987 allowing private sector electricity production for the national grid, which prior to that time had been the sole monopoly of the NPC. EO 215 received final approval and was implemented in mid-1989. Within a year, nine private power projects with a combined capacity of 271 MW had been approved (Sullivan 1990), and in 1991 the first commercial-scale private power generation occurred with the commissioning of a 210-MW diesel-fired gas turbine facility built and operated by Hopewell Energy Ltd. under a build-operate-transfer (BOT) contract (OEA 1992). In addition to the BOT scheme — where a private company contracts to finance, build, and operate a plant, sell power to the NPC, and then turn the plant over to the NPC after an agreed upon period of time (typically 10-20 years) — there are a number of other schemes for private participation in power generation in the Philippines. These include build-transfer-operate, where a private company finances and constructs a plant, transfers ownership to NPC, and then operates the plant under a renewable management contract, as well as build-own-operate, rehabilitate-operate-manage, and rehabilitate-operate-lease. Although begun too late to stave off the power crisis, the Philippine private power program is considered to be one of the best designed and implemented in the developing world (Sullivan 1990; McCandless 1993). The program has been successful at mobilizing the capital and expertise needed to overcome the power shortages hampering economic development. In fact, interest in the program has been so great that it appears that the largest portion of incremental generating capacity needed in the Philippines by the year 2000 may well be constructed by private power developers.

Assessment of the Aquino Energy Program

Despite the serious power crisis and increased reliance on imported oil that characterized energy sector issues during the Aquino administration, there were a number of positive developments as well. Exploration activity in the oil and gas sector increased markedly in the latter part of Aquino's term, highlighted by major offshore discoveries at West Linapacan (oil), Malampaya (oil and gas), and Camago (gas), all northwest of Palawan Island (Figure 1.3). Commercial production at Linapacan started in May 1992, flowing 15 to 30 thousand b/d, or around 10% of the country's oil requirements. Recoverable reserves from this field are estimated at around 100 million barrels, giving Linapacan an expected lifespan of 15 to 20 years. Malampaya is believed to hold at least 300 million barrels of recoverable reserves, with an initial production target of 20 to 40 thousand b/d. The Camago gas field has so far been estimated to contain from .6 to 1.2 trillion cubic feet (tcf) of recoverable gas reserves, or the equivalent of 100-200 million barrels of oil. Development of the Camago field is contingent upon further proving of gas at nearby Malampaya since an estimated 2.5 to 4 tcf of reserves are needed in order to economically justify the construction of a 350-km pipeline and generating capacity on Luzon to utilize this gas (NPC 1991; OEA 1992).

In other areas, efforts were begun to draft a new geothermal law which would repeal an earlier service contract law requiring geothermal producers to share 60% of the profit from production with the government. This provision was largely responsible for a levelling off of activity in the geothermal sector since the mid-80s. Progress has also been made in interconnecting a number of major island grids in the country which will make over 1,000 MW of potential geothermal capacity in Leyte and Negros accessible to more populated and industrialized areas of the country. The Panay-Negros-Cebu interconnection was completed in 1993, while the Leyte-Cebu, Leyte-Luzon, and Leyte-Mindanao interconnections are expected to be completed between 1997 and 2000 (see Figure 1.3). The private power program begun by Aquino started to show results in 1991, and has provided the framework necessary to overcome power shortages and meet most incremental demand through the rest of the decade. Overall, by the time Fidel Ramos assumed the presidency in mid-1992, concerted efforts were underway to resolve the most serious problems in the Philippine energy sector.

The Ramos Energy Plan: 1993-2000

Energy Projections

Table 1.11 presents recent projections of the commercial energy mix in the Philippines up to the year 2000 based on a government-assumed average GDP growth rate of 6.2% per annum, and a GDP elasticity of energy demand of 1.1 (OEA 1992; DOE 1993). Commercial energy demand is forecast to grow an average of close to 7% a year during this period, nearly doubling by the end of the decade. Indigenous energy production is projected to increase more than three-fold over the plan period, with oil and geothermal accounting for the bulk of this expansion. As a result, the share of imported energy is expected to drop from 72% to 40%, with imported coal accounting for nearly half of all imported energy requirements by 2000. Demand for electric power is forecast to grow from 7 to 12% a year depending upon the assumptions made (NPC 1991; OEA 1992; DOE 1993). This growth in electric power demand translates into a need for an additional 5,400 to 9,700 MW of capacity, or an 80% to 140% increase in capacity over current levels.

One of the most striking aspects of the projections given in Table 1.11 is the expected increase in domestic oil production. An official long-term energy plan published by the Office of Energy Affairs in early-1992 forecast domestic oil production levels of only 1.5 million boe by 2000 (OEA 1992). However, in a postscript to that document mention was made of recent discoveries and development of the Linapacan and Malampaya fields, and a draft of the revised energy plan prepared by the newly-created Department of Energy in 1993 foresees production from Linapacan, Malampaya and Octon fields reaching anywhere from 12 million boe in 1995 to 82 million boe in 1999 under a "high" scenario of full field development at all three (DOE 1993). In addition, gas finds at the Camago field and in surrounding formations at Malampaya and Iloc are estimated to hold reserves of as much as 4.6 to 5.8 tcf, or close to 1 billion boe. The most optimistic scenario calls for production of 600-700 million cubic feet per day by the year 2000, to be pumped to Luzon via a 350-kilometer (offshore) pipeline in order to power 3,000-4,000 MW of electric generating capacity (NPC 1991; DOE 1993).

After oil, geothermal power is expected to show the most rapid growth over the plan period, tripling to over 30 million boe by the year 2000 (Table 1.11). Geothermal development is expected to receive a boost with interconnection of the Leyte-Cebu and Leyte-Luzon electric grids by 1997 or 1998, and amendments to the geothermal service contract law which should attract increased private sector investment in this resource. Projections call for development of over 1,500 MW of additional capacity, including power from smaller fields like Makban, Bulusan, Bacon-Manito and Del Gallego in Luzon, as well as development of close to 1,000 MW of capacity at the Tongonan field in Leyte in time to provide power to the interconnected grids of Cebu and Luzon (NPC 1991). In an effort to help diversify the predominantly hydro-based generating mix of the Mindanao grid, work is also underway to interconnect Mindanao with Leyte, and to develop 240 MW of geothermal capacity at the Mt. Apo field in Davao for start-up by 1998. However, the schedule for interconnection has been pushed back, and environmental and tribal opposition to the Mt. Apo project has held-up work there, prompting the World Bank to withhold loans for the project citing an unsatisfactory environmental impact assessment as the cause (Mincher 1993).

Domestic coal production is forecast to increase from 5.1 million boe (1.5 million metric tons) in 1993 to 14.7 million boe (4.2 million tons) by 2000 (Table 1.11), with most of this increase coming from the government-owned

Semirara mine (OEA 1992; DOE 1993). Government intervention will still be required in order to guarantee a market for domestic coal, since local mines usually cannot compete with imported suppliers. The coal sector development plan calls for continued blending of local coal with higher-quality imported supplies, upgrading of quality through benefication, and construction of new mine-mouth power plants designed specifically to run on low-quality domestic supplies (OEA 1992). In addition, the NPC will be required to purchase at least 10% of their coal requirements from domestic producers, while quantitative restrictions on coal imports will be eliminated in favor of higher import duties (DOE 1993). Despite these policies, the contribution of *imported* coal to the commercial energy mix is forecast to increase from 2.5 million boe in 1992 to 44.7 million boe in 2000 (Table 1.11), with supplies coming mainly from Australia, China, Indonesia and Vietnam. The projected 681% increase in consumption of both domestic and imported coal over the plan period is due in large part to plans for an eight-fold increase in coal-fired electric generation capacity, as well as a doubling of coal demand in the cement industry.

With the exception of the possible commissioning of a 268-MW hydroelectric plant at Casecnan, Luzon by the year 2000, and development of as many as 35 smaller hydro sites to provide power to local rural electric cooperatives, very little growth is forecast in the hydroelectric sector (DOE

1993; McCandless 1993). Industrial consumption of nonconventional energy is forecast to grow from 14.7 million boe in 1992 to 25.3 million boe by 2000 (Table 1.11). Much of this growth will be accounted for by increased bagasse consumption in the sugar industry, although efforts are also underway to develop biomass cogeneration facilities in a number of other industries. Although not included in Table 1.11, fuelwood and charcoal consumption in the residential and small-scale industrial sectors is expected to increase slightly from 75 million boe in 1992 to 83.3 million boe by 2000, with economic development and urbanization trends (which tend to depress woodfuel use) offsetting absolute increases in the rural population (DOE 1993).

Overall, commercial energy consumption in the Philippine economy is forecast to increase from 132.5 million boe in 1992 to 226.7 million boe in 2000 (Table 1.11). Projections call for a near quadrupling of domestic energy production, resulting in an absolute drop in energy imports of 4% over the plan period, and a 31.4% decline in imported energy's share of the total. Meanwhile, the composition of energy imports is forecast to shift from being 97% oil to about an equal split between oil and coal. Domestic oil production is expected to increase 100-fold over the plan period, although these projections may be overly optimistic given the history of false starts in the Philippine oil industry over the past 15 years (Paderanga and Paderanga 1988).

The assumed economic growth rate of 6-7% per annum upon which the energy projections are based may also be too optimistic given recent economic performance and obstacles to development still in place in the country. One of the main obstacles to development as of 1992 was the inadequacy of electric power supply, and so it is not surprising that immediately after being elected president in mid-1992, Ramos made a resolution of the power crisis one of his top domestic priorities.

Recent Developments and Projections in the Electric Power Sector

After less than a year in office, President Ramos persuaded Congress to approve Republic Act No. 7648, also known as the Electric Power Crisis Act of 1993. This act allows the president to by-pass public bidding procedures for critical ("fast-track") power projects, raise electricity tariffs, reorganize NPC and increase salaries and incentives for necessary technical personnel over existing government limits (Mincher 1993; McCandless 1993). Ramos has used these powers to expedite a number of private sector power projects intended to provide critical short-term relief to the islands of Luzon and Mindanao, primarily in the form of oil-based thermal plants with relatively short lead times. By late-1993, ten private power projects with an aggregate capacity of 1,086 MW were in place, power interruptions in Manila were nearly eliminated, and over 2,000 MW of additional capacity from private developers was scheduled to come on-line by the mid-1990s (McCandless

1993). Figure 1.11 presents the projected power generation mix in the Philippines up to the year 2000. Power sector projections are subject to some uncertainty due to the increased involvement of private developers. The NPC has its own development plan to the year 2005, but the trend appears to be to allow private sector developers to finance and build as much of the needed incremental generating capacity as possible. This approach reduces the capital requirements of the government for power sector expansion, and tends to speed up addition of new capacity since private power developers can avoid the time-consuming government procurement and audit procedures required of the NPC.

Up to 1995, additions to installed capacity will be primarily in the form of oil-fired plants, including a 520-MW combined-cycle facility designed to run on diesel while utilizing waste heat to generate additional power. The share of oil-fired plants in the *capacity* mix will peak at around 55% in 1993 before dropping to 39% by the year 2000. Meanwhile, the start-up of large baseload geothermal and coal-fired plants between 1995 and 2000 will facilitate the use of oil-fired plants primarily for peaking purposes. Therefore, the share of oil-fired plants in the *generating* mix will drop from around 56% in 1994 to only 19% by 2000 (Figure 1.11). With the development of close to 1,000 MW of geothermal capacity in Leyte, 200 MW in Luzon, and 240 MW at Mt. Apo in Mindanao, the share of geothermal in the *capacity* mix rises from 13% in 1992 to 20% by 1999. Since geothermal systems operate at a higher plant factor (see Table 1.3) and are intended for baseload purposes, the share of geothermal power in the *generating* mix is forecast to increase from 22% to 34% during the same period (Figure 1.11). The largest projected additions to capacity are in the form of coal-fired plants. Coal's share in the *capacity* mix is forecast to grow from 6% in 1992 to 24% by 2000. Like geothermal, coal-fired plants are intended to be utilized primarily for baseload generation, and so coal's share in the actual power *generation* mix is expected to increase from 7% in 1992 to 34% by 1999 (Figure 1.11). Virtually all of the additional coal-fired capacity will be located in Luzon, including as much as 1,800 MW of capacity to be built by private sector developers under BOT contracts (NPC 1990). Over 80% of coal-fired generation is expected to come through the use of imported coal supplies, although this figure could go significantly higher or lower depending on developments in the domestic coal industry, changes in import duties and quantitative restrictions on imported coal, and the long-term feasibility of constructing mine-mouth power plants designed to run exclusively on domestic supplies. Available data on development and operating costs of various power options in the Philippines (see Table 1.3) indicate that the government's power sector expansion plans are based on some notion of a least-cost generation mix.

While not explicitly addressed in the long-term energy plan, a potentially important source of increased power supply could be obtained through improvements in plant capacity factors and reductions in transmission and distribution (T&D) losses. Recent studies of power sector issues in developing countries suggest that a combination of improvements in capacity factors, T&D losses and efficiencies of end-use devices could substantially reduce capacity expansion needs, and that power sector planning in these countries should be based on an objective function of optimizing the utilization of capital across the entire power sector (including generation, transmission, distribution, system rehabilitation and end-use efficiencies) rather than one of least-cost generation alone (Jhirad 1990; Meier 1990). In the Philippines, T&D losses were reported to be in the range of 18% in the early-80s, and anywhere from 12 to 15% by 1990-92 (OEA 1992; NSCB 1993), with these figures representing a combination of technical and non-technical losses. Technical losses can be reduced to more optimal levels through investment in maintenance and upgrade of the distribution system. Non-technical losses arise mainly through pilferage of electricity, often by large consumers of power. An existing provision in the billing structure in the Philippines allows utilities to recoup losses from theft by passing on these costs to paying customers, thereby removing much of the incentive for electric companies to go after pilferers. Elimination of this provision appears likely in the near future, as do new and tougher penalties for power pilferage.

Additional Opportunities and Constraints in the Philippine Energy Sector

Under Marcos, the Philippine government took an active role in promoting energy conservation through the use of a variety of policy approaches. Much of this effort was targeted at the industrial sector since the objective at the time was to reduce *oil* demand and industry was the largest oil consumer in the economy. Today, however, the primary concern in the Philippine energy sector is with *electricity* demand, and so a broader approach to improving energy efficiency is called for. Figure 1.12 presents the sectoral breakdown of electricity consumption in the Philippines for the years 1981-1992. During this period the fastest growth in power consumption took place in the residential sector, increasing over 10% a year since 1986 compared with overall growth in consumption of only 2.8% a year. As a result, the residential share in total electric consumption has risen from 16.2% in 1986 to 24.7% in 1992. As in other parts of Asia, rising per capita incomes, increased urbanization, and the spread of electric service to previously unelectrified rural areas are all responsible for rapidly increasing residential sector power demand in the Philippines (Sathaye 1987; Schipper and Meyers 1991). Power demand in this sector is projected to continue to increase at above average rates for the rest of this decade.

Cognizant of the growing importance of the residential sector in overall energy consumption, the Philippine government in 1989 undertook a household energy consumption survey (HECS) intended to generate information on energy use patterns and identify policy interventions for improving end-use efficiencies (Pujanes 1993). The HECS revealed that a significant potential exists for cost-effective electricity savings in the residential sector, primarily through improvements in appliance efficiency and more rapid penetration of compact fluorescent lighting. While estimates of potential electricity savings and cost of conserved electricity (CCE) from efficiency programs are sensitive to assumptions made regarding consumer discount rates and other variables, analyses done for the Philippines, as well as for other developing countries, typically reveal that the CCE is substantially less than the marginal cost of generating and supplying an additional unit of power (Wilbanks 1990; Meyers *et al.* 1990; Schipper and Meyers 1991; UNDP/ ESMAP 1992; DOE 1993). Since residential sector lighting and appliance use in developing Asian countries like the Philippines tends to create evening peaking problems, end-use efficiency improvements in this sector may be disproportionately more attractive since these would reduce the need for peaking capacity which has a much higher marginal cost than an equivalent amount of baseload capacity (Meyers *et al*. 1990; Busch 1991).

The Philippines is in a relatively good position to implement an effective energy efficiency program for a number of reasons. First, President Ramos recently elevated the OEA to departmental status with the creation of the Department of Energy (DOE) in 1993. The DOE boasts a modern fuel and appliance testing laboratory (FATL), and can benefit from the accumulated experience in energy efficiency programs built up since the Marcos years. Second, an energy conservation bill is currently pending in Congress that will provide the DOE with additional resources to promote conservation while simultaneously authorizing them to set and enforce mandatory standards on appliance, equipment and vehicle efficiencies (DOE 1993). However, as in other developing Asian nations a number of obstacles still exist to fully exploiting the conservation/efficiency potential in the Philippines. High consumer discount rates create first-cost sensitivity problems for energy efficient appliances, marketing approaches of multinational and local appliance manufacturers usually stress style and first-cost affordability over efficiency, a biased planning approach on the part of the NPC limits the objective function to least-cost capacity expansion only, and subsidized pricing of electricity and other forms of energy reduce incentives for investing in efficiency improvements (Schramm 1990; Meier 1990; Reddy 1991; Schipper and Meyers 1991). The fact that the DOE is either planning to or has already begun to address most of these issues bodes well for the country realizing its conservation objectives. Mandatory energy requirement labelling of major appliances should heighten consumer awareness of conservation potentials, although it may do little to help overcome first-cost sensitivity problems. If it passes, the energy conservation bill will do much to make *avoided* capacity as legitimate an objective in power planning as *additional* capacity. Finally, in terms of electricity pricing, the Philippines already has the highest average tariff rates in the region (McRae 1992), and there are indications that in the future subsidized rates for small-scale consumers will be eliminated. The DOE has set cumulative targets for the 1993-2000 period of 18 million boe saved through industrial management audits, 1,972 million kWh (8% of demand in 1992) of electricity savings through labelling of air conditioners, refrigerators and ballasts, and 810 MW of avoided capacity through increased penetration of compact fluorescent lighting in commercial establishments, office buildings and residences (DOE 1993).

Options for increased commercial-scale utilization of the country's abundant biomass resources are also being considered. Significant progress on both technical and economic grounds has already been made in other countries in advanced biomass utilization systems, and these systems often hold the added advantage of reducing both local- and global-scale environmental impacts (Hall 1991; Johansson *et al.* 1993). One of the most promising options for the Philippines is development of biomass-integrated gasifier/gas turbine (BIG/GT) systems for production of electricity or for cogeneration purposes. The BIG/GT systems can be designed to run on agricultural or forest product residues, as well as on biomass grown on dedicated energy plantations (OTA 1992; Williams and Larson 1993). Since

1973, interest in commercial-scale biomass conversion in the Philippines has come in fits and starts, with a number of programs (e.g. the dendrothermal) making significant progress only to fall victim to political upheaval and/or sudden changes in world oil prices. Future development of commercial-scale biomass energy systems should therefore be pursued only in those cases where it can be shown to be an economically viable energy option, although R&D efforts should continue to be pursued in order to identify promising options.

If recent progress in the Philippine energy sector is to be sustained, a number of critical constraints will need to be addressed. First, the long-term energy plan calls for over $20 billion in investments in the energy sector from 1993 to 2000, with 74% of this total in the form of foreign exchange (DOE 1993). Approximately $15 billion of total investment is to go to the power sector, with three-fourths of this to be met by the government and the rest by the private sector. Given the already large foreign debt of the Philippines, the magnitude of energy sector investments suggests the need for greater private sector participation in energy development, a trend already begun by Aquino with the opening up of power generation. Second, over the years a number of energy projects in the country have been met with resistance on environmental grounds, including hydroelectric dams, the BNPP, coal-fired plants and, most recently, development of geothermal power at Mt. Apo in

Mindanao. While the magnitude and scope of the power crisis affecting the country since 1989 has weakened the environmental argument, it would be unfortunate and counterproductive if local health and ecological considerations were overlooked in the rush to meet capacity expansion requirements (Wilbanks 1990; Hills 1991). Finally, energy planning in the Philippines has long been criticized for being too "politicized" (Habito and Intal 1988; Siddayao 1988; Paderanga and Paderanga 1988; Razavi 1991). A recent example of this tendency involved President Aquino announcing *reductions* in prices of petroleum products just days after announced *increases* in electric rates were met with strong public protest. In an effort to move beyond this pattern, the groundwork has been laid for full deregulation of the oil industry by 1996, and the NPC is in the process of developing a pricing system for electric power that will automatically reflect changes in its operating costs due to fluctuations in exchange rates or prices for oil and coal. A critical requirement for the Ramos energy program to succeed will be for planning and implementation in the energy sector to be as transparent and proactive as possible, in contrast with the disjointed and *ad hoc* approach of his predecessor. Perhaps it would not be an overstatement to predict that success or failure in the energy sector over the next 8-10 years will determine whether or not the Philippines joins the rest of the Southeast Asian region in dynamic economic growth, or continues to stand out as the exception.

Conclusion

• In 1973, the Philippines was dependent on imported oil for 92% of its commercial energy requirements. Exposure to oil supply uncertainties and rising prices led to economic slowdown, a one billion dollar reversal in the national trade balance, and an increased reliance on foreign loans to pay for oil imports.

• In response to the 1973 oil crisis, the Philippine government undertook a two-pronged program of indigenous energy development and energy conservation/efficiency promotion. Domestic oil, hydroelectric, geothermal, coal and non-conventional energy production increased from 5.6 million boe in 1973 to 41.6 million boe in 1985, in the process reducing the country's dependence on imported oil from 92 to 55%. Energy conservation and efficiency improvements were encouraged through a combination of high domestic energy prices, investment incentives, mandatory industrial energy audits, equipment labelling and other government initiatives. As a consequence, the *energy* intensity of the Philippine economy declined an average of 2.2% a year over the 1973-85 period.

• The Philippine government also encouraged the substitution of non-oil fuels for oil in a number of industries, especially in the electric power sector. Over the 1973-85 period, fuel substitution in the electric power industry helped reduce potential oil imports by approximately 42 million boe, equivalent to 90% of oil imports by the country in 1985. Oil displacement also occurred in the industrial and residential sectors. Due to the combination of energy conservation/efficiency improvements and oil displacement in various sectors, the *oil* intensity of the Philippine economy declined an average of 5.1% a year over the 1973-85 period.

• Overall, the Marcos energy program is estimated to have reduced potential oil imports by close to 280 million boe between 1973 and 1985. This translates into a foreign exchange savings to the Philippine economy of $7.2 billion, or a 38% reduction in the country's oil import bill for the period. However, in realizing these savings billions of dollars had to be borrowed and invested in the development of domestic energy industries, generally with little consideration for whether domestic energy was a lower-cost alternative to imported oil. By the mid-80s, energy sector issues were overshadowed by political and economic turmoil, resulting in revolution and the ouster of Marcos in February 1986.

• Under the new administration of Corazon Aquino the Philippine economy rebounded from negative economic growth rates of previous years. A combination of economic revival and declining international and domestic oil prices resulted in a reversal of trends in the Philippine energy sector. By the end of Aquino's term in 1992 dependence on imported oil had risen again to 70%, and oil imports were double those of 1985. Between 1986 and 1992 the energy intensity of the Philippine economy increased 15%, while the oil intensity went up 51%.

• The most serious energy issue for the Aquino administration was not, however, dependence on imported oil. Instead, the major concern was with a domestic electric power crisis which began to be felt in the late-80s and which, by 1991-92, was resulting in power outages of 6-14 hours daily throughout much of the country. The power crisis came about due to a combination of the cancellation of power projects begun by Marcos, lack of planning and coordination in the energy sector, drought-induced reductions in hydroelectric generation, and the imposition of structural adjustment programs on the Philippine economy which limited government investment in infrastructure projects. In 1992, the power crisis is estimated to have cost the Philippine economy anywhere from US$381 to 1523 million in lost output, or the equivalent of from 1.5 to 5.8% of national GDP. Unreliable power supply has also hampered government efforts to attract foreign investment in the economy.

• Rapid growth in electric power demand and a shortage of government financial capital prompted the Aquino government to launch a private power program in 1989, opening up power generation for the national grid to the private sector. By mid-1992, when Fidel Ramos replaced Aquino as president, a number of private power plants were already operating. Ramos' ability to address the power crisis was strengthened in 1993 with the passage of the Electric Power Crisis Act allowing him to take emergency measures to deal with power shortages. By late-1993, ten private power plants with a combined capacity of 1,086 MW were operating, close to 2,000 MW of additional capacity was scheduled to come on-line in the near future, and power outages in much of the country had been reduced to only 1-2 hours per day.

• The medium-term energy plan of the Ramos administration forecasts an increase in domestic energy production from 37.5 million boe in 1992 to 135.3 million boe by 2000. The largest increases in domestic energy production are to come from development of oil and gas fields offshore of Palawan Island and from a tripling of power generation from geothermal. As a result, dependence on imported oil is forecast to decline from 70% in 1992 to 20.6% in 2000. Overall energy import dependence will only drop to 40.3% since projections call for a twenty-fold increase in electric power generation from coal-fired power plants using imported coal from Australia, Indonesia and China. Most of the incremental electric generating capacity needed in the country is expected to come from private sector power projects, and the reliability and diversity of electric power supply will be enhanced by 1997 with the full interconnection of the Visayan and Luzon power grids.

• Opportunities exist to further enhance energy supply security in the Philippines through improvements in the efficiency of energy use, reductions in transmission and distribution (T&D) losses in the power sector, and development of technologies to convert the nation's abundant biomass fuel resources into modern energy carriers. Efficiency improvements in the residential sector appear particularly promising since this sector has *not* been the target of government programs in the past, and since efficiency gains in this sector can help reduce evening electric peaking power requirements. Revisions in the utility rate structure will eliminate subsidies to small-scale power consumers and promote conservation and efficiency, while new and tougher laws against power pilferage will be implemented which should help to bring T&D losses down. Biomass gasification and other conversion technologies could play an important role in any future energy mix in the Philippines, although failures in commercial-scale biomass conversion programs in the past have tempered government enthusiasm for these types of programs unless clear economic advantages are apparent.

• Continued progress in the Philippine energy sector is contingent upon the government overcoming shortages of financial capital, reconciling the often-conflicting objectives of energy supply and environmental quality, and reducing the extent to which energy sector planning and decision-making is driven by short-term political considerations. Allowing the private sector to finance and construct most of the incremental electric generating capacity in the country under build-operate-transfer, build-transfer-operate and other schemes, will bring government capital requirements down to more manageable levels and insure the timely addition of capacity to the grid. Environmental considerations figure prominently in government energy reports, but in practice may be ignored in the process of trying to overcome power shortages and meet projected increases in commercial energy demand of 7% per year for the rest of the decade. Finally, efforts are underway to "de-politicize" energy policy in the Philippines through the privatization of the oil industry and automatic indexing of electric power rates to fuel prices and exchange rate fluctuations. It is hoped that these moves will reduce the incentive to the government to use energy pricing and supply as a means to achieve purely political objectives.

Table 1.1: Energy-economy indicators for the Philippines, 1973-1992

		Average per year						
	1973	1974-76	1977-79	1980-82	1983-85	1986-88	1989-91	1992
Change in GDP (%/year)	8.8	5.9	5.4	4.0	-4.3	4.8	2.6	-0.3
Change in Energy Consumption (%/year)	–	6.3	5.1	-0.6	-1.0	5.4	3.1	8.2
Change in Oil Consumption (%/year)	–	1.5	5.2	-4.2	-9.9	10.1	5.0	16.9
Energy Intensity (boe/'000 1972 Pesos GDP)	1.14	1.15	1.13	0.99	1.00	1.05	1.08	1.18
Oil Intensity (boe/'000 1972 Pesos GDP)	1.05	0.93	0.91	0.73	0.61	0.63	0.69	0.83
Population (millions)	40.9	43.1	46.2	49.6	54.3	58.7	61.5	64.3
Urban Population (%)	34.6	35.6	36.7	37.9	39.5	41.0	42.6	43.8
Energy Per Capita (boe/person/year)	1.7	1.8	2.0	1.9	1.8	1.8	1.9	2.1
Oil Import Volume (million boe/year)	64.2	64.0	72.9	67.3	54.4	57.7	74.3	92.5
Oil Import Bill (million US$/year)	231	810	1223	2420	1738	1060	1575	1660
Exchange Rate (Peso/US$)	6.8	7.2	7.4	8.0	15.5	20.7	24.5	25.3
Balance of Trade (million US$/year)	307	-885	-1017	-2027	-1235	-1767	-3256	-4195
Oil Bill as % of Trade Deficit	–	91.5	120.0	119.4	140.7	60.0	48.4	39.6
External Debt (billion US$)	2.0	3.3	10.7	21.0	25.1	29.0	30.2	–

Sources: OEA 1992; ADB 1992; World Bank 1993; NSCB 1993

Table 1.2: Historical energy mix in the Philippine economy, 1973-92, in million barrels of oil equivalent (boe) and percent of total

	1973		1977		1981		1985		1989		1992	
	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%
Domestic Energy	**5.6**	**8.0**	**17.0**	**19.0**	**26.3**	**28.1**	**41.6**	**45.0**	**41.8**	**35.6**	**37.5**	**28.3**
Oil	–	–	–	–	1.4	1.5	2.6	2.8	1.7	1.5	0.6	0.5
Coal	0.1	0.2	0.9	1.0	0.9	0.9	4.5	4.8	4.2	3.5	5.1	3.8
Hydro	3.2	4.6	3.3	3.7	6.4	6.8	9.5	10.3	11.2	9.6	7.3	5.5
Geothermal	–	–	–	–	4.7	5.1	6.5	8.5	9.2	7.8	9.8	7.4
Non-Conventional[a]	2.3	3.2	12.8	14.3	12.9	13.8	16.5	17.9	15.5	13.2	14.7	11.1
Imported Energy	**64.2**	**92.0**	**72.7**	**81.0**	**67.2**	**71.9**	**51.0**	**55.0**	**75.5**	**64.4**	**95.0**	**71.7**
Oil	64.2	92.0	72.7	81.0	67.2	71.9	47.0	50.7	72.5	61.8	92.5	69.8
Coal	–	–	–	–	–	–	4.0	4.3	3.0	2.6	2.5	1.9
Total Energy	**69.8**	**100**	**89.7**	**100**	**93.5**	**100**	**92.6**	**100**	**117.3**	**100**	**132.5**	**100**

Sources: OEA 1992; NSCB 1993

[a] The non-conventional category represents consumption of bagasse, wood wastes and other forms of agricultural and forest residues by large-scale industrial consumers, excluding the much larger volume of biomass fuel consumed by households and small-scale industrial and commercial establishments throughout the country.

Table 1.3: Summary of electric power alternatives in the Philippines

Development Option	Investment Cost ($/KW)	Plant Factor (%)	Levelized Generation Cost (¢/kWh)	Lead Time (months)
Geothermal	2103	85	4.7	24-36
Imported Coal	1336	75	5.6	36-48
Combined Cycle	825	80	5.7	18-24
Hydroelectric	3170	59	8.5	72-96
Diesel	900	80	10.6	18-24
Gas Turbine	546	15	15.6	12-24

Source: OEA 1992

Table 1.4: Oil displacement in the Philippine electric power sector due to fuel substitution, 1973-85, in million boe

	(1)	(2)	(3)	(4)	(5)
	Total Energy	Base-Year Oil Share	Hypothetical Oil Use	Actual Oil Use	Oil Displacement
Year	$E_{j,t}$	$S_{j,b}$	(1)*(2)	$O_{j,t}$	$D_{j,t}$ ((3)-(4))
1973	12.9	.746	9.6	9.6	–
1974	17.0	.746	12.7	12.9	-0.2
1975	18.0	.746	13.4	13.9	-0.5
1976	19.4	.746	14.5	14.4	0.1
1977	21.1	.746	15.7	17.0	-1.3
1978	23.3	.746	17.4	18.2	-0.8
1979	24.5	.746	18.3	18.1	0.2
1980	28.6	.746	21.4	18.6	2.8
1981	29.1	.746	21.7	17.6	4.1
1982	30.7	.746	22.9	17.5	5.4
1983	32.5	.746	24.2	18.3	5.9
1984	34.5	.746	25.7	14.6	11.1
1985	34.9	.746	26.1	11.0	15.1
Total					**41.9**

Source of data: ADB 1992

Table 1.5: Relative contribution of non-oil energy sources to oil displacement in the Philippine electric power sector, 1980-85, in percent of total and million boe (mboe)

	1980	1981	1982	1983	1984	1985	Total
Geothermal							
%	57.1	63.4	66.7	83.0	55.0	44.4	57.4
mboe	1.6	2.6	3.6	4.9	6.1	6.7	25.5
Hydroelectric							
%	35.7	34.2	25.9	6.8	32.4	25.2	26.1
mboe	1.0	1.4	1.4	0.4	3.6	3.8	11.6
Coal							
%	7.2	2.4	7.4	10.2	12.6	30.4	16.5
mboe	0.2	0.1	0.4	0.6	1.4	4.6	7.3
Total (mboe)	2.8	4.1	5.4	5.9	11.1	15.1	44.4

Sources of data: ADB 1992; OEA 1992

Table 1.6: Oil displacement in the Philippine industrial sector due to increased coal use, 1973-85, in million boe

	(1)	(2)	(3)	(4)	(5)
	Total Energy	Base-Year Oil Share	Hypothetical Oil Use	Actual Oil Use	Oil Displacement
Year	$E_{j,t}$	$S_{j,b}$	(1)*(2)	$O_{j,t}$	$D_{j,t}$ ((3)-(4))
1973	23.89	.9974	23.82	23.82	–
1974	19.36	.9974	19.31	19.28	0.03
1975	23.23	.9974	23.17	23.05	0.12
1976	24.97	.9974	24.90	24.76	0.14
1977	27.22	.9974	27.15	26.66	0.49
1978	27.39	.9974	27.32	26.78	0.54
1979	28.93	.9974	28.86	28.48	0.38
1980	29.62	.9974	29.54	29.02	0.52
1981	26.64	.9974	26.57	26.05	0.52
1982	23.84	.9974	23.77	23.26	0.51
1983	27.13	.9974	27.06	25.67	1.39
1984	19.09	.9974	19.04	16.39	2.65
1985	18.82	.9974	18.77	16.61	2.16
Total					**9.45**

Source of data: ADB 1992

Table 1.7: Commercial energy and oil intensities of nine Asian countries, 1973, 1979 and 1985, in tons of oil equivalent (toe) per million US$ GDP (at constant 1980 prices), and average annual growth rate (AAGR) in intensities over 1973-85 period, in percent

	Energy Intensity				Oil Intensity			
	1973	1979	1985	AAGR	1973	1979	1985	AAGR
Bangladesh	205	206	251	1.7	102	105	90	-1.0
India	543	624	639	1.4	173	191	190	0.8
Indonesia	268	392	418	3.8	250	299	256	0.2
South Korea	581	632	583	0.0	371	426	297	-1.8
Malaysia	382	386	401	0.4	315	337	309	-0.2
Pakistan	502	557	610	1.6	202	210	231	1.1
Philippines	419	371	321	-2.2	398	338	211	-5.1
Taiwan	600	685	585	-0.2	414	496	301	-2.6
Thailand	414	408	385	-0.6	387	368	247	-3.7
Average	**435**	**473**	**466**	**0.6**	**290**	**308**	**237**	**-1.7**

Source: ADB 1992

Table 1.8: Commercial energy intensities of the industrial, transportation and residential/ service sectors in the Philippines, and average annual growth rates (AAGR) in percent, 1978 and 1984

	1978	1984	AAGR (%)
Industry (toe/million US$ of value added in constant 1980 prices)	394	278	-5.8
Transportation (toe/vehicle/year)	3.0	2.1	-5.8
Residential/Service (toe/1,000 persons/year)	24.5	18.5	-4.7

Source: Sathaye *et al.* 1987

Table 1.9: Estimated commercial energy savings in the Philippine economy from energy conservation and efficiency improvements, 1973-85, in million boe

	(1)[a]	(2)[b]	(3)[c]	(4)[c]	(5)[c]
	Base-Year Energy Intensity	Year t GDP	Hypothetical Energy Use	Actual Energy Use	Energy Savings
	N_b	GDP_t	(1)*(2)	Y_t	F_t ((3)-(4))
1973	1.14	61.3	69.8	69.8	–
1974	1.14	64.3	73.3	75.2	-1.9
1975	1.14	68.4	78.0	79.4	-1.4
1976	1.14	73.9	84.2	83.9	0.3
1977	1.14	78.5	89.5	89.7	-0.2
1978	1.14	82.8	94.4	94.1	0.3
1979	1.14	88.0	100.3	97.4	2.9
1980	1.14	92.6	105.6	96.9	8.7
1981	1.14	96.2	109.7	93.5	16.2
1982	1.14	99.0	112.9	95.6	17.3
1983	1.14	99.9	113.9	98.5	15.4
1984	1.14	93.9	107.0	93.7	13.3
1985	1.14	89.8	102.4	92.5	9.9
Total					**80.8**

Source of data: OEA 1992
[a] boe/'000 1972 Pesos GDP
[b] billion Pesos
[c] million boe

Table 1.10: Estimates of the economic impact of power shortages on the Philippine economy, 1990-92, in million US$ and as a % of GDP

	1990	1991	1992[a]
Annual Change in GDP(%)	2.7	-0.8	-0.3
Unserved Power Demand (million kWh)	406	793	1269
Cost Estimates	1990	1991	1992[a]
Case 1 (¢30/kWh)			
million $	122	238	381
% of GDP	0.3	0.5	1.5
Case 2 (¢60/kWh)			
million $	244	476	761
% of GDP	0.6	1.1	2.9
Case 3 ($1.20/kWh)			
million $	487	952	1523
% of GDP	1.1	2.1	5.8

Sources of data: IBON 1990; Tancongco 1992
[a] First six months of 1992 only.

Table 1.11: Projected commercial energy mix of the Philippine economy, 1992-2000, in million boe and percent of total

	1992		1995		1998		2000	
	Vol.	%	Vol.	%	Vol.	%	Vol.	%
Domestic Energy	**37.5**	**28.3**	**61.3**	**39.5**	**98.8**	**50.1**	**135.3**	**59.7**
Oil	0.6	0.5	11.6	7.5	25.8	13.1	55.9	24.6
Coal	5.1	3.8	6.8	4.4	10.9	5.6	14.7	6.5
Hydro	7.3	5.5	9.0	5.8	8.5	4.3	9.1	4.0
Geothermal	9.8	7.4	14.7	9.4	31.0	15.7	30.3	13.4
Non-Conventional	14.7	11.1	19.2	12.4	22.6	11.4	25.3	11.2
Imported Energy	**95.0**	**71.7**	**93.9**	**60.5**	**98.5**	**49.9**	**91.4**	**40.3**
Oil	92.5	69.8	86.5	55.7	75.0	38.0	46.7	20.6
Coal	2.5	1.9	7.4	4.8	23.5	11.9	44.7	19.7
Total Energy	**132.5**	**100**	**155.2**	**100**	**197.3**	**100**	**226.7**	**100**

Sources: NSCB 1993; DOE 1993

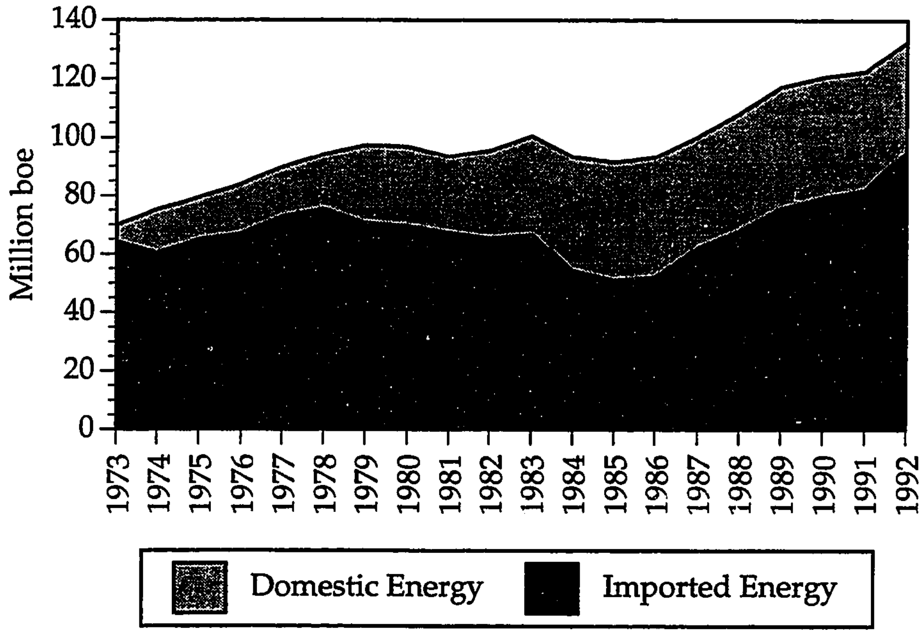

Figure 1.1: Relative contribution of domestic and imported energy to the Philippine commercial energy mix, 1973-1992, in million barrels of oil equivalent (boe). Sources: OEA 1992; NSCB 1993

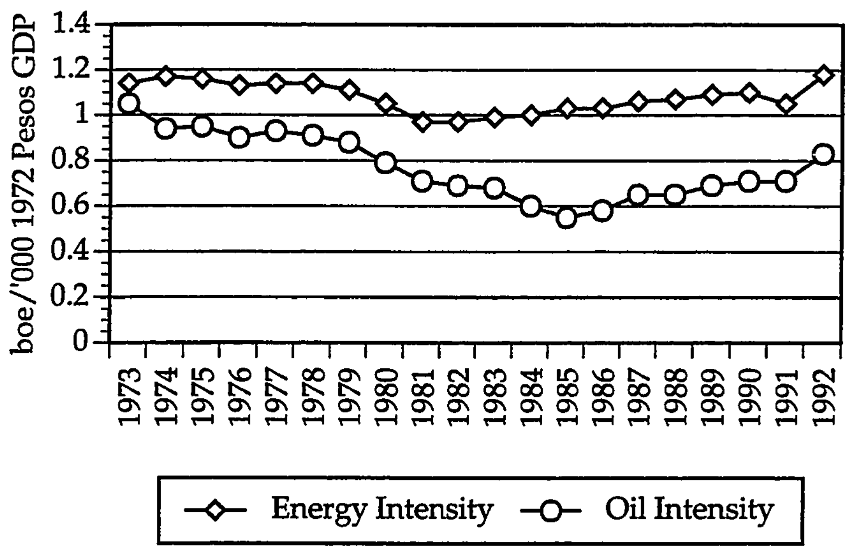

Figure 1.2: Energy and oil intensities of the Philippine economy, 1973-1992, in boe per constant (1972) 1,000 Pesos GDP. Sources: OEA 1992; NSCB 1993

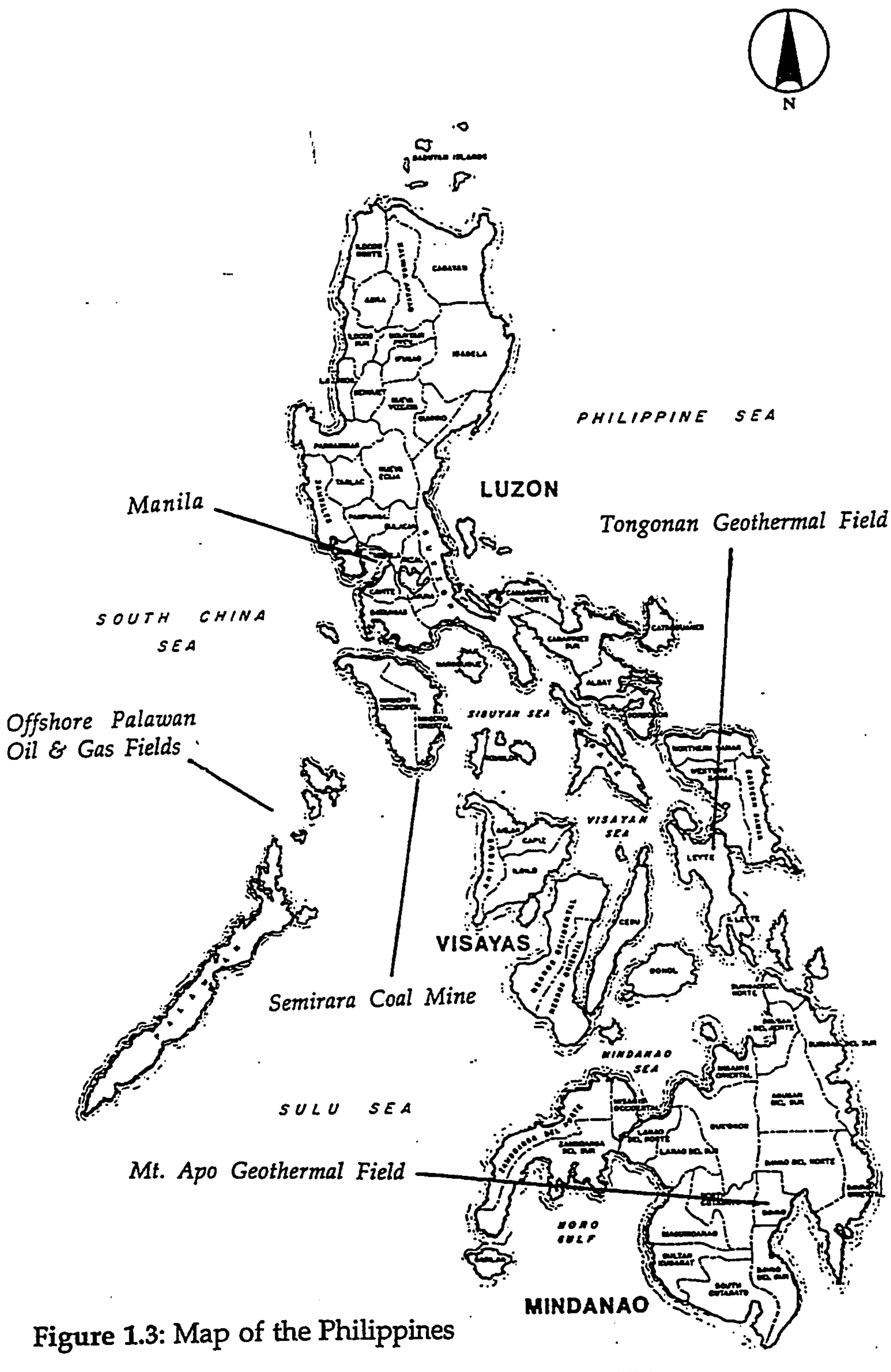

Figure 1.3: Map of the Philippines

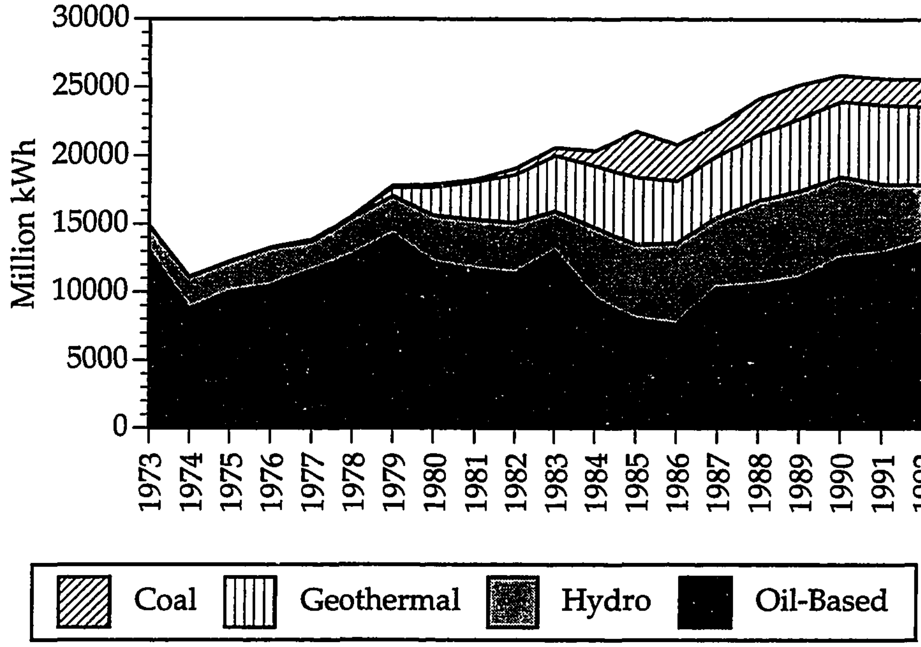

Figure 1.4: Electric power generation in the Philippines, by plant-type, 1973-1992, in million kWh. Sources: OEA 1992; NSCB 1993

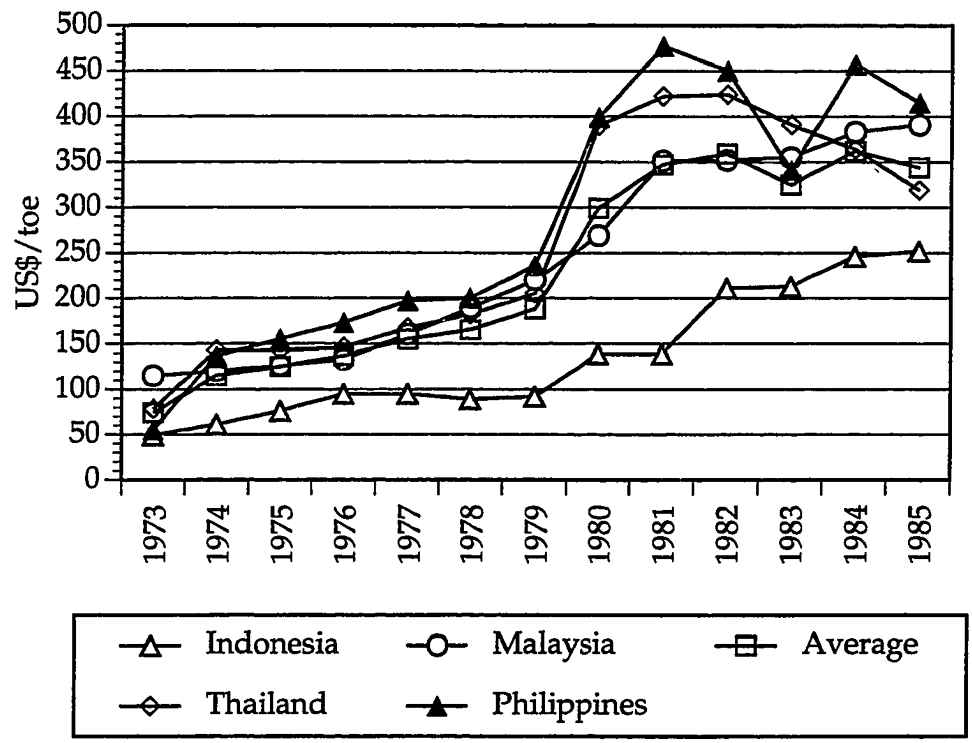

Figure 1.5: Average oil prices in four ASEAN nations, 1973-1985, in US $/toe. Source: ADB 1992

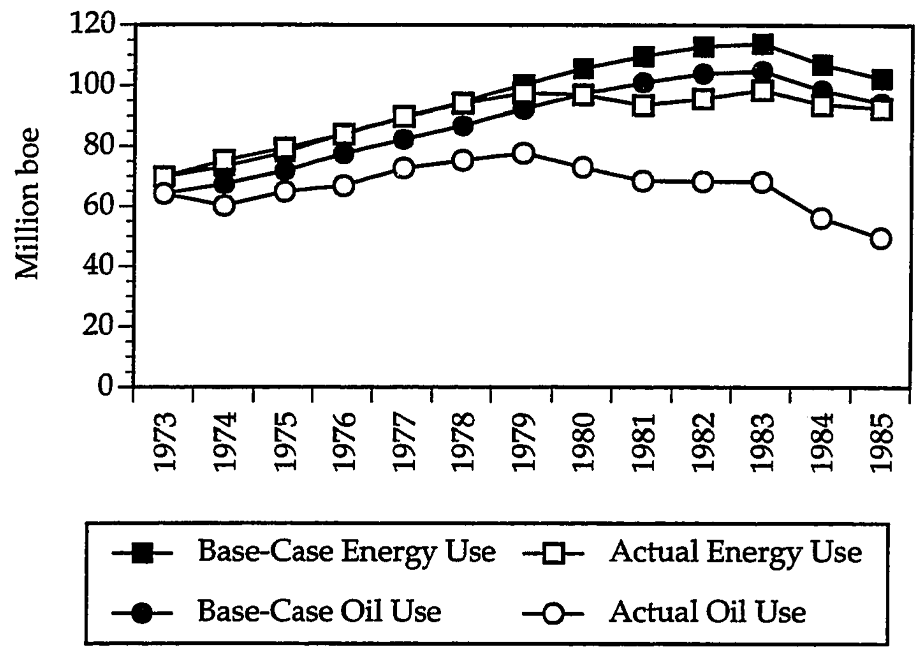

Figure 1.6: Actual energy and oil consumption in the Philippine economy, 1973-85, versus hypothetical base-case consumption where energy intensity and oil share remain at 1973 levels, in million boe. Source of data: OEA 1992

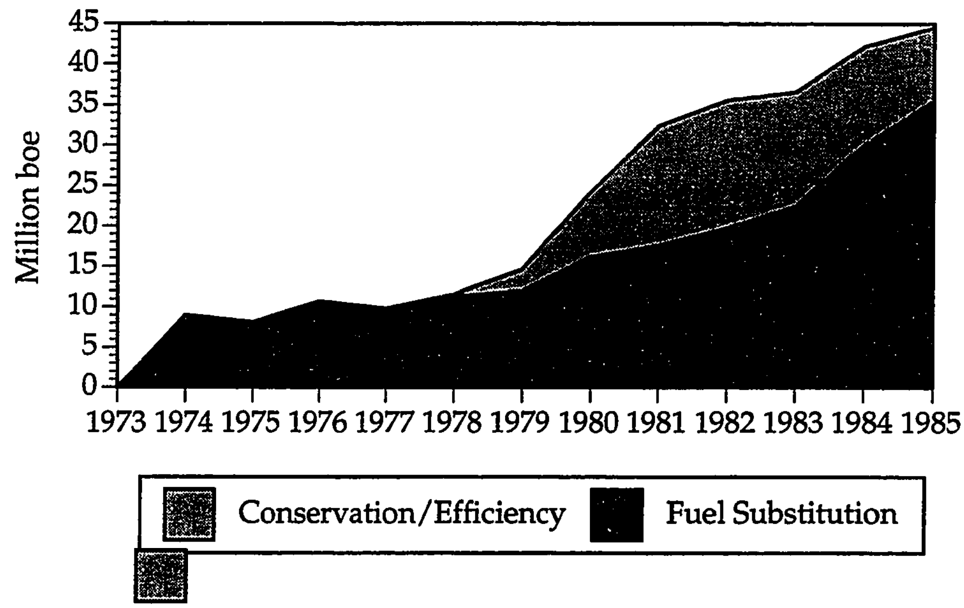

Figure 1.7: Comparative yearly oil savings in the Philippines from fuel substitution efforts and energy conservation/efficiency practices, 1973-1985, in million boe.

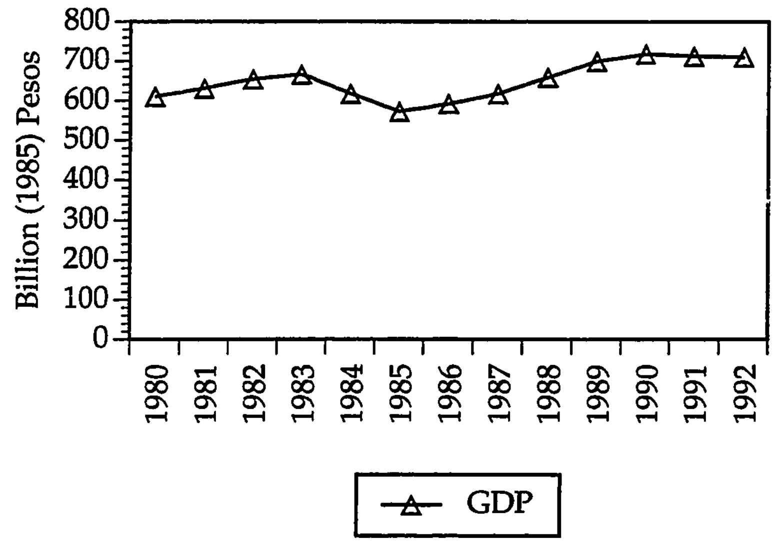

Figure 1.8a: Philippine gross domestic product (GDP), 1980-92, in billion 1985 (constant) Pesos. Source: NSCB 1993

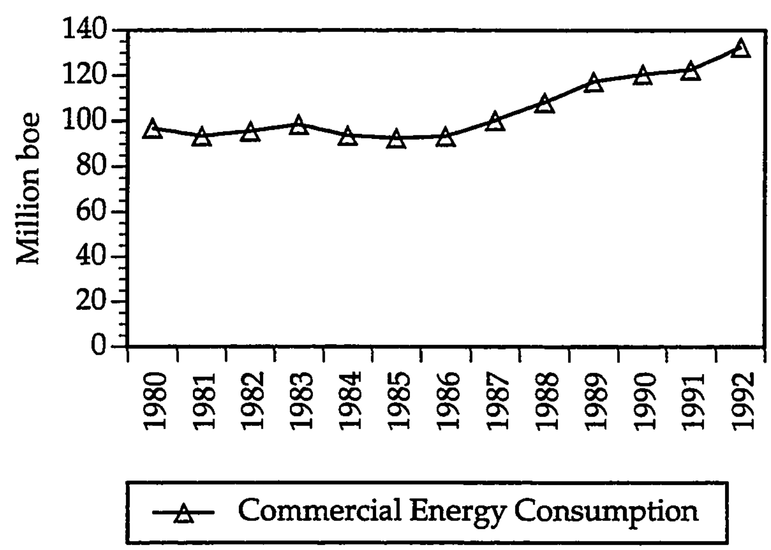

Figure 1.8b: Commercial energy consumption in the Philippines, 1980-92, in million boe. Sources: OEA 1992; NSCB 1993

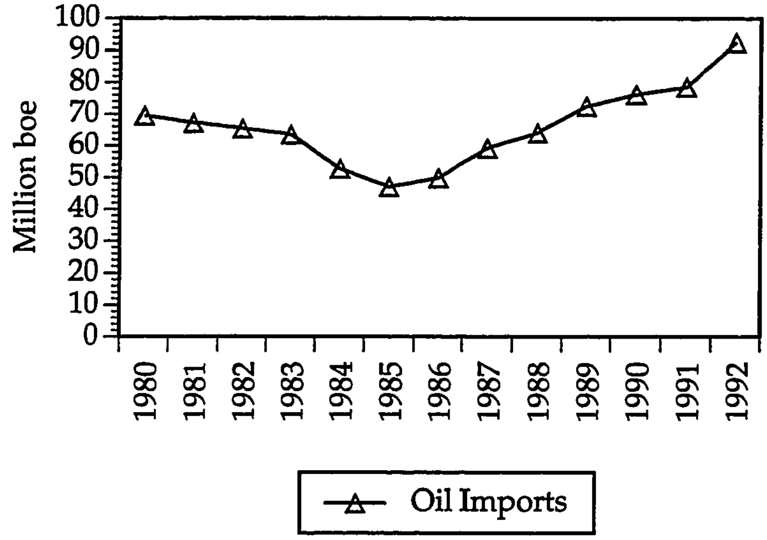

Figure 1.8c: Philippine oil imports, 1980-92, in million boe. Sources: OEA 1992; NSCB 1993

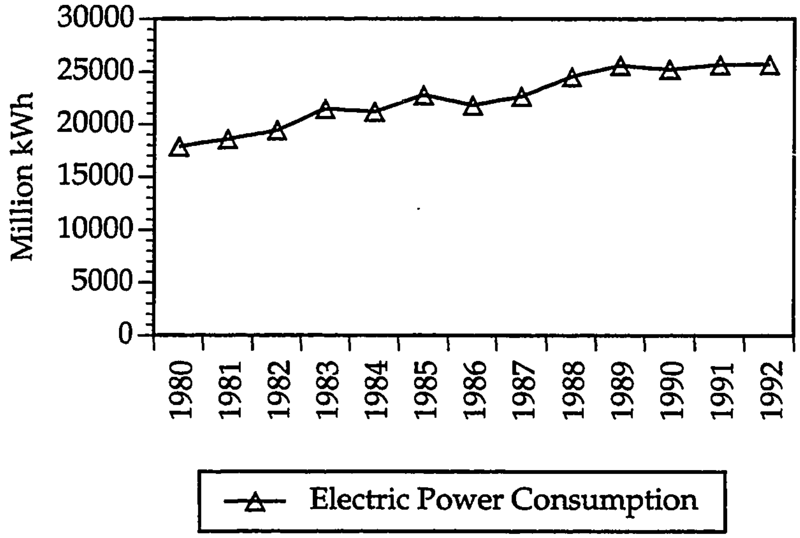

Figure 1.8d: Electric power consumption in the Philippines, 1980-92, in million kWh. Source: NSCB 1993

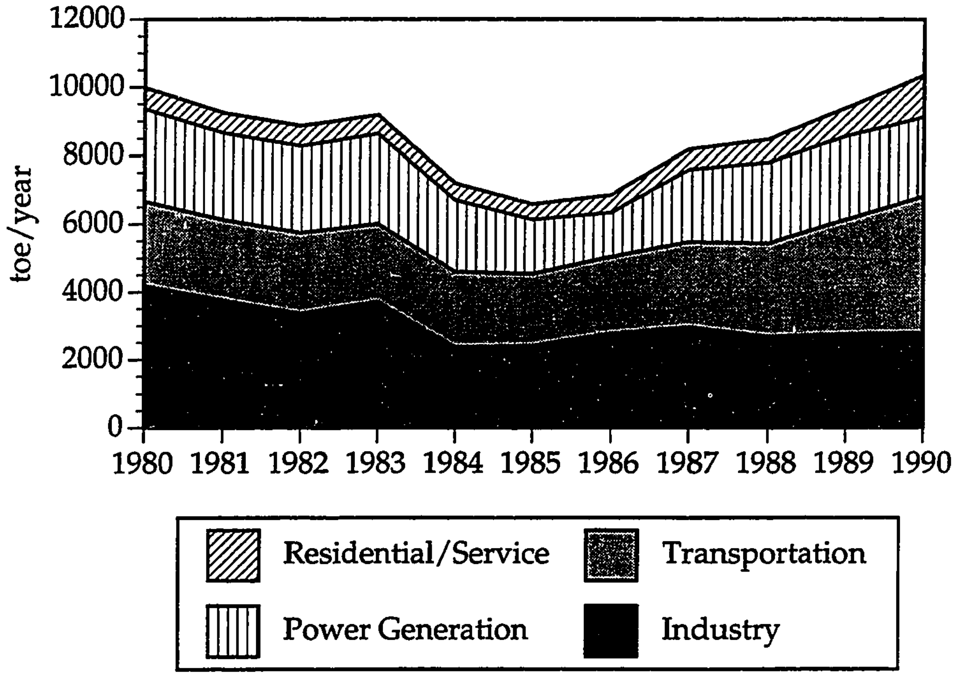

Figure 1.9: Oil consumption in the Philippine economy, by sector, 1980-90, in toe/year. Source: ADB 1992

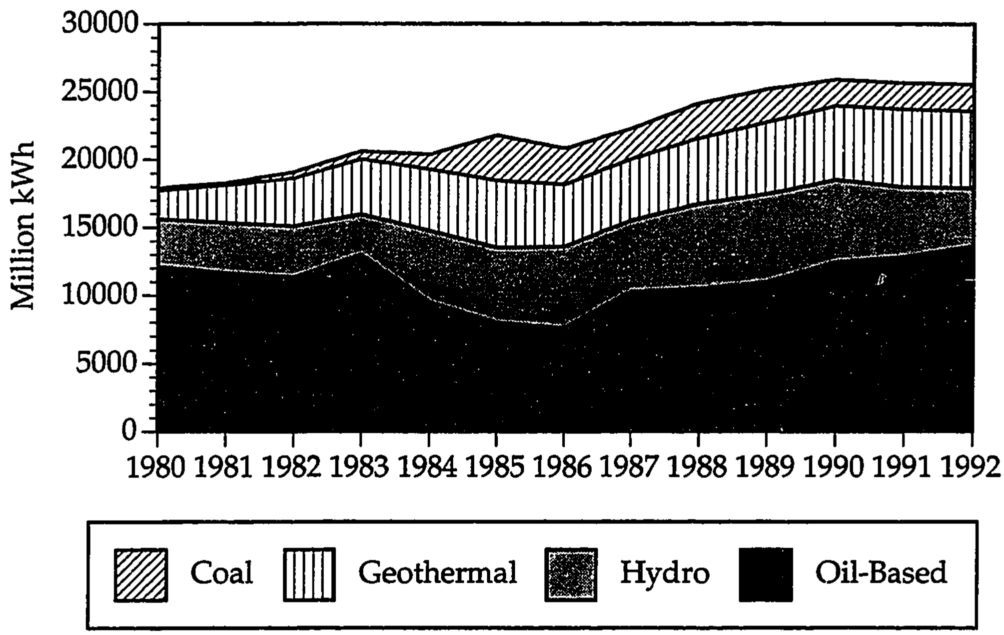

Figure 1.10: Electric power generation, by plant-type, 1980-92, in million kWh. Source: NSCB 1993

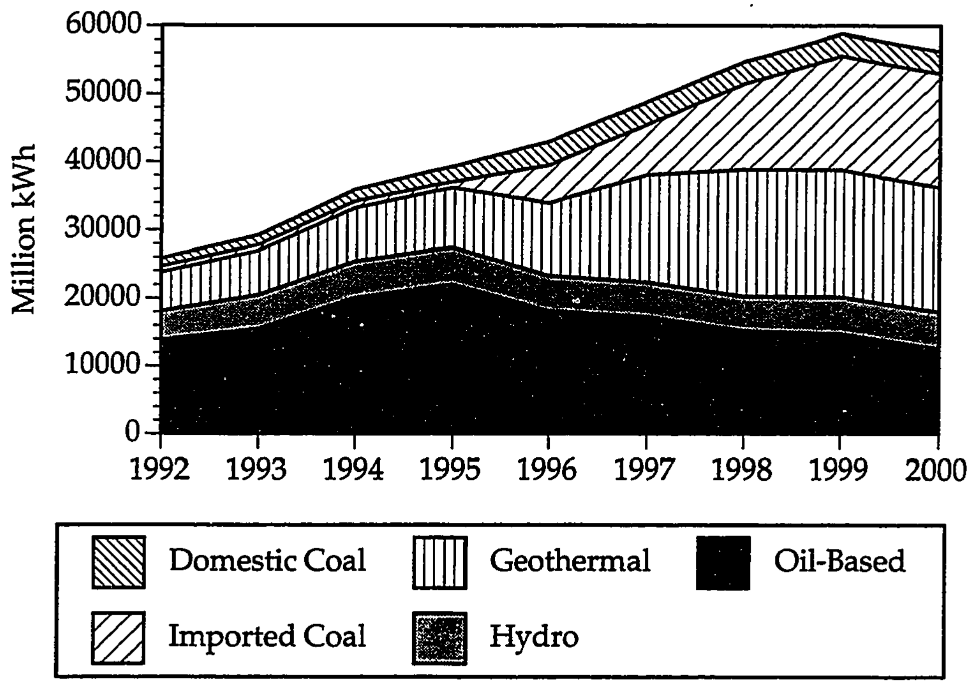

Figure 1.11: Projected power generation mix in the Philippines, by plant-type, 1992-2000, in million kWh. Sources: OEA 1992; DOE 1993

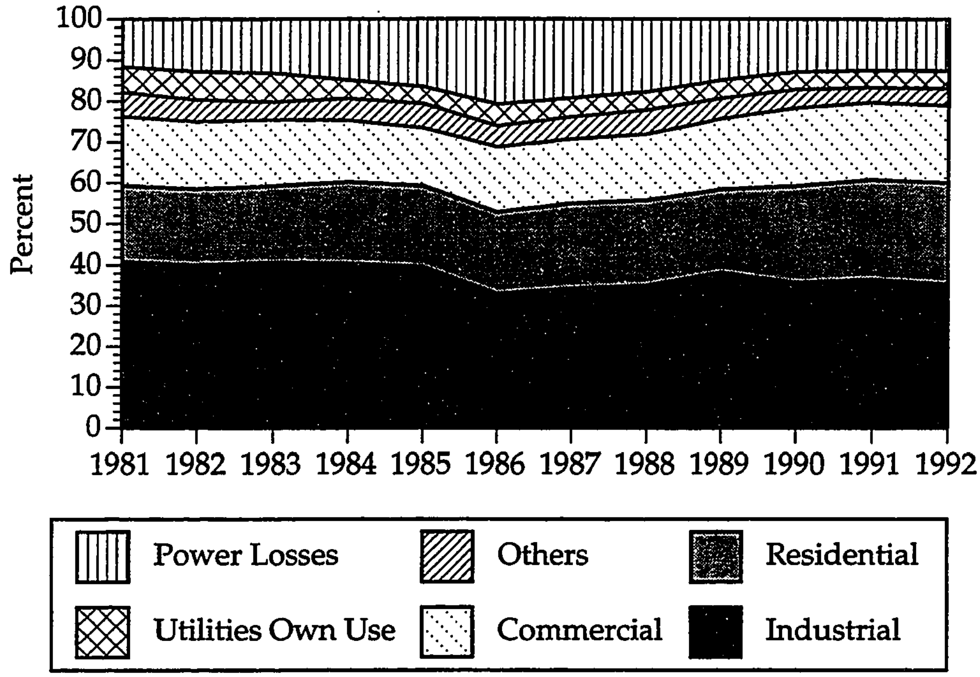

Figure 1.12: Electric energy consumption in the Philippines, by sector, 1981-92, in percent of total consumption. Source: NSCB 1993

CHAPTER 2

THE ROLE OF COMMERCIAL WOODFUEL MARKETS IN PROMOTING AGROFORESTRY AND REFORESTATION PRACTICES IN CEBU PROVINCE, PHILIPPINES

Introduction

The island province of Cebu, in the central Philippines, is generally considered to represent one of the worst cases of extreme environmental degradation in that country or the Southeast Asian region. With virtually no forest cover, predominantly steep terrain, and the highest population density of any of the major islands in the country (520 persons/km^2), Cebu is believed to be on the brink of ecological collapse and has been labeled a "desert island" and an "ecological disaster" (Collins 1990). Widespread dependence on woodfuels by the island's 2.7 million inhabitants is often pointed to as a major cause of Cebu's environmental problems. Of particular concern is the concentrated woodfuel demand of households and businesses in the Cebu City metropolitan area, which has a population of 1.1 million. This concern has prompted government and NGO officials in the region to call for tighter restrictions on the commercial woodfuel trade, and even for an outright ban on the sale of fuelwood and charcoal in the city.

In this paper we argue that rather than being a cause of environmental degradation in the province, the commercial woodfuel trade in Cebu is inducing more widespread tree-planting and woodlot management among rural Cebuanos, in the process helping to reduce or at least stabilize soil erosion in the island's upland environment. This argument is based on the results of a recently-completed research effort which examined three aspects of the commercial woodfuel industry in Cebu — the demand for woodfuels by households and businesses in urban Cebu, the trading network which moves fuels from rural producers to urban consumers, and the woodfuel production and management practices of Cebuano farmers. The discussion below will focus primarily on the second and third aspects of the research; details of urban woodfuel consumption patterns in Cebu can be found elsewhere (Bensel and Remedio 1993).

Given the potentially positive role of the commercial woodfuel trade in improving Cebu's rural environment, and the importance of this $10 million a year industry in providing at least supplemental income and employment to over 35,000 Cebuano households (7% of the island's population), any plans to ban or more tightly regulate the trade should be carefully reviewed. In fact, the discussion below will illustrate why commercial markets for woodfuel and other wood products in places like

Cebu can be viewed as a potential *opportunity* to promote sustainable agriculture and other land use practices, rather than as a *problem* to be dealt with through urban inter-fuel substitution programs or punitive restrictions on wood harvest and transport. Before turning to the specifics of woodfuel management and trade in Cebu, a review of the connections between woodfuel use and environmental degradation in developing regions of the world is in order.

Woodfuel Use and Environmental Degradation

Woody and non-woody biomass fuels (including fuelwood, charcoal, agricultural and animal residues) currently meet 14% of the world's energy requirements, and account for 35% of the energy consumed in developing countries (Rosillo-Calle and Hall 1992). Globally, over 2 billion people rely on biomass fuels for their daily cooking and heating needs, and in a number of African and Asian countries biomass fuels meet over 90% of national energy requirements (Gregersen *et al.* 1989; Hall 1991). High levels of dependence on fuelwood and charcoal in developing nations has been cited as one of the main causes of tropical deforestation in these regions (Hertzmark 1987; Hume 1988; Park 1992; Rowe *et al.* 1992). As a result of deforestation, a large percentage of the developing world's population is said to be residing in areas of woodfuel shortage, with a widely-cited FAO report estimating that close to 100 million people live in areas of "acute woodfuel scarcity", while over 1 billion live in woodfuel deficit areas (de Montalembert and Clement 1983). In addition, it is widely speculated that concentrated urban woodfuel demand, and the commercial woodfuel markets that develop to meet this demand, have a much greater negative environmental impact than comparative levels of rural demand, aggravating rural woodfuel shortages and resulting in woodland destruction moving like "rings" outward from urban centers (Manibog 1984; Wood and Baldwin 1985; Bowonder *et al.* 1987, 1988; Barnes 1990; Bertrand 1991).

The apparent link between woodfuel use and deforestation, and especially between highly commercialized urban woodfuel use and local degradation, has formed the basis for policy and program interventions in many developing countries over the past twenty years (Baldwin *et al.* 1985; Pitt 1985; Munslow *et al.* 1988; Dewees 1989; Soussan *et al.* 1990; Soussan *et al.* 1992). These interventions have usually been based on one or both of the following perspectives (see Dewees 1989). First, that woodfuel demand is a major cause of deforestation. Second, and because of deforestation, woodfuel supplies have (or will) become increasingly scarce. As a result, policy and project interventions have typically been designed to either reduce woodfuel demand, increase supplies, or some combination of the two. Demand-side programs have focused on the promotion and dissemination of improved wood-burning stoves or on efforts to facilitate inter-fuel substitution away from woodfuels, with the latter usually achieved through subsidized pricing of alternative cooking fuels such as kerosene and LPG. Supply-side approaches have aimed to establish woodfuel plantations, especially in peri-urban areas, or to encourage increased planting and management of trees by farmers in woodfuel deficit areas.

A number of woodfuel policy and program interventions have achieved reasonable success, such as widespread adoption of the fuel-efficient, ceramic-lined "Jiko" charcoal stoves in urban areas of Kenya (see Baldwin *et al.* 1985; Hyman 1987; H.M. Jones 1989; Banwell and Harriss 1992). However, a review of the existing literature suggests that project failures have far outnumbered successes, and that a fairly common explanation for such disappointing results is that target populations have tended not to share the government's or implementing agency's sense of concern over existing or impending woodfuel shortages (Foley 1987; Gill 1987; Leach and Mearns 1988; Dewees 1989; Cline-Cole *et al.* 1990a). This divergence between the official perception of the problem and the local view has, in turn, been attributed to such factors as poverty-induced myopia and the presence of "open-access" woodland areas. With regards to the latter, it is often reported that the availability of fuelwood from open access woodlands results in market failure since this situation leads to an underpricing of woodfuels and therefore reduced incentives to invest in fuel-efficient woodstoves or to undertake tree-planting on private lands (French 1986; Leach 1988; Clarke and Shrestha 1989; Mercer and Soussan 1992).

Such factors have undoubtedly limited the effectiveness of woodfuel policy and project interventions in many cases. But there is also evidence that many woodfuel sector interventions have failed (1) because they were based on an erroneous link between woodfuel use and deforestation, (2) because they exaggerated the degree of existing or impending woodfuel shortages, and (3) because they failed to recognize that target populations may have already begun to adapt to impending woodfuel shortages in less obvious, but equally effective ways. For example, Foley (1987) reports that official concern over woodfuel shortages in the Sahelian region may be exaggerated because of a failure to recognize the importance of agricultural fallow areas and trees grown on farms in meeting regional woodfuel demands. Dewees (1989) and Cline-Cole *et al.* (1990a) suggest that a variety of demand- and supply-side adaptations on the part of woodfuel consumers and producers — including fuel-switching, changes in cooking patterns, increased use of non-woody biomass fuels, and more intensive tree-planting and management on farmlands — have combined to reduce woodfuel pressures in a number of areas of Africa. Wiersum and Veer (1983) point out that a World Bank-funded program designed to increase woodfuel supplies by encouraging smallholder treefarming in two northern Philippine provinces generated little in the way of local interest since farmers were already producing large quantities of fuelwood from intensively-managed shrub fallows which had been overlooked by project planners. Finally, Saxena (1993a) comments that official estimates of woodfuel supply potential in India fail to account for large areas of public lands covered in *Prosopis spp*. shrubs, even though such areas produce abundant quantities of fuelwood.

These examples are not intended to suggest that there is no longer a woodfuel problem in developing regions of the world, or that woodfuel extraction is never a cause of deforestation. Rather, they are presented in order to make the case that projected woodfuel shortages often don't materialize because woodfuel management and consumption practices can be far more complex and adaptive than is usually recognized. In addition, these examples imply that woodfuel sector policy and project interventions that fail to recognize this complexity and adaptiveness will be largely ineffective. Not all adaptations to a tightening of woodfuel supplies are positive, such as when agricultural and animal residues traditionally used for soil enhancement purposes are diverted to substitute for declining wood supplies, or when cooking and meal preparation practices are altered with negative health or nutritional consequences (Barnard 1985; Fleuret 1990-91; Mercer and Soussan 1992). Nevertheless, local adaptations to a deteriorating woodfuel supply-demand situation often have few or no negative impacts, and in many cases can result in positive changes in land use or resource management practices — such as when tree farming or agroforestry is adopted by smallholders. This suggests a need to approach the study of woodfuel production and use in as site-specific a manner as possible, to acknowledge the potential for creative adaptations to woodfuel stress on the part of affected populations, and to recognize the impact that economic, social and political developments have on the functioning of local woodfuel systems.

Of particular interest to this work is the contribution of non-forest lands to meeting local woodfuel demands, and the possibility that commercial woodfuel markets may be encouraging more intensive tree-planting and management practices by farmers in developing regions. Although it is widely assumed that urban woodfuel demand and increasing population densities result in an intensification of open access woodland destruction and woodfuel shortages in surrounding areas, very few attempts have actually been made to empirically document such a connection (see for instance Bowonder *et al.* 1987; Sagawe 1991; Soussan *et al.* 1991). On the other hand, there is growing evidence to suggest that in rural regions closely linked to urban economies, farmer tree-planting and other forms of intensive biomass management may actually increase (see Arnold 1992). Such a situation appears to arise due to an interaction of increasing population densities and changes in the intensity of farm management, changes in local labor markets due to the presence of off-farm urban employment opportunities, and changes in land use and cropping patterns due to the existence of commercial markets for woodfuel and other wood products.

For instance, Bradley *et al.* (1985, 1988) found that in Kakamega District, Kenya, areas with the highest population densities supported the greatest amounts of on-farm woody biomass due to the increased intensity of farm management practices in these regions. Similar findings were encountered in high population density, peri-urban regions around Kano, Nigeria (Cline-Cole *et al.* 1990b). Godoy (1992) cites cases in Kenya and Indonesia where farmers devoted most or all of their lands to tree-farming in order to allow them to pursue off-farm wage labor in nearby urban areas (see also Barbier 1990). Olofson (1985) argues that farmers in Rizal Province, Philippines, often devote large portions of their lands to trees and shrubs when faced with labor shortages within the family. Saxena (1992a, b, 1993b) reports that in the state of Uttar Pradesh and other agricultural regions of India, commercial tree-farming is an attractive option for "off-site" (urban-based) farmers and landowners because it is easier from a management standpoint. Finally, Gregersen *et al.* (1989) and Smiet (1990) cite commercial markets for woodfuel and other wood products as an important reason for increased tree-planting and management among upland farmers in various parts of Java, Indonesia.

These examples raise a number of interesting issues which are important to consider in any assessment of woodfuel production and use in a given area, as well as in designing policy and/or project interventions intended to improve the local woodfuel situation. First, in most developing regions the bulk of woodfuel consumed by the populace comes from trees and shrubs grown on farms and in managed fallow systems, not from forests (Leach and Mearns 1988; Smiet 1990; Soussan 1991; Mercer and Soussan 1992; Ouerghi 1993). Koopmans (1993) estimates that in nearly every developing Asian country (with the exception perhaps of Nepal), the largest share of woodfuel requirements are met from trees growing outside of the forest, with countries like Bangladesh, Sri Lanka and the Philippines meeting 87, 75 and 85% of their respective woodfuel needs from non-forest sources. Second, the factors that influence smallholder decision-making with regards to tree-planting and management for woodfuel or other purposes are far more complex and site-specific than a general notion of an impending woodfuel shortage (Hosier 1989; Barbier 1990; Godoy 1992). Third, and somewhat related to the previous point, the *types* of trees grown by smallholders and the *intensity* with which these are managed will depend on such factors as the local land tenure situation, labor markets, wood product markets and government regulations regarding the cutting and transport of trees and shrubs grown on private lands.

In Cebu, over-cutting of trees for local woodfuel needs and for sale in urban markets is regularly pointed to as one of the major causes of deforestation on the island (Zafra n.d.; Seidenschwarz 1988; Aliño 1989; DENR 1991a). Consequently, the near total absence of primary forests on the island has popularized the perception that Cebu soon will be, or already is experiencing acute woodfuel shortages. An FAO report refers to Cebu as a fuelwood deficit zone (de Montalembert and Clement 1983), while a more recent study sponsored by the Philippine Department of Environment and Natural Resources (DENR) classifies Cebu as one of nine provinces nationwide experiencing "very heavy stress" in terms of biomass fuel supplies (DAP 1992). Wiersum (1982) and Hyman (1983a) have cited the importation of fuelwood into Cebu from neighboring islands as a sign of local woodfuel shortages. Contrary to these assessments, our research leads us to conclude that the overall biomass fuel supply-demand picture in Cebu is favorable, and that supplies will remain adequate if current woodfuel-producing land use practices do not undergo significant change in the future. Importation of woodfuels into Cebu appears to account for only a fraction of a percent of total consumption, and is primarily a function of a specific demand by bakeries for wood from certain species of mangrove not found locally, rather than an indication of widespread fuelwood shortages on the island (Bensel and Remedio 1993).

In order to better understand how Cebu — with its high population densities and absence of natural forest — can maintain its self-sufficiency in woodfuels, we need to consider more carefully the actual woodfuel production and management practices of smallholders and landowners in agricultural and mixed land use areas. The discussion above suggests that in a densely-populated, rapidly urbanizing region like Cebu, attention must be paid to the influence that factors such as land tenure and land ownership patterns, local labor markets, regulations on woodfuel harvest and transport, national government energy policy and local woodfuel and wood product markets can have on tree-planting and management decisions of smallholders and other landowners. The next section presents some background information on economic and natural conditions in Cebu in order to provide the context for a discussion of woodfuel management systems and marketing practices in the region.

The Study Site

Cebu is situated in the Central Visayan region of the Philippines, 550 kilometers south-east of Manila (Figure 2.1). The island is long and narrow, stretching 220 kilometers on a north-south trend, while only 40 kilometers in breadth at its widest point. With the exception of a narrow coastal plain, Cebu's topography is dominated by steep terrain and a central mountain range which reaches 1,000 meters and runs almost the entire length of the island. Nearly three-fourths of the land area is over 18% in slope, and half is greater than 30% in slope (Table 2.1). Soils are primarily of limestone origin. The island receives an annual average rainfall of 1,638 mm (64.5 inches), with no pronounced dry or wet season.

The Cebu City metropolitan area is the commercial and industrial center of the southern Philippines. Since 1987 the economy of Metro Cebu has grown rapidly, with some economic indicators pointing to growth rates as high as 15% per annum (Tiglao 1991; RDC 1993). Local and provincial planners envision continued high growth rates through the rest of the decade, and they are touting Cebu as the next "tiger economy" of the Asia/Pacific region (PPDO 1990). Key industries include coconut oil, carrageenan, rattan furniture, handicrafts, watches, semiconductors, toys, clothing, and dried fruits. The medium-term development plan for the province is based largely on an expansion of industrial zones and manufacturing centers in Metro Cebu and other selected areas of the province, as well as on further development of tourist sites in coastal and interior locations (FARDEC 1991; RDC 1993). Job prospects in industry, retail establishments and in the booming construction industry of Metro Cebu have drawn increasing numbers of migrants from rural areas of the province as well as from surrounding islands. Between 1980 and 1990, the population of

Metro Cebu grew at an average rate of 3.1% per annum, while the rural population grew at only 1.9% a year over the same period (NSO 1992). While the economic boom currently underway in Metro Cebu may be able to accommodate some of this migratory influx, the regional Department of Labor and Employment is warning that job creation cannot keep pace, and there are indications that rapid urban population growth is straining the city's environment and infrastructure services (So 1991; Sino-Cruz 1992; Gonzales 1992).

In contrast with the economic boom underway in urban Cebu, the rural economy of the island is characterized in large part by near-subsistence farming and fishing activities, although cash-cropping and small rural industries (e.g. handicraft manufacture, coal mining) are locally important in some areas. The staple food crop among rural Cebuanos is corn, with lands planted to this crop covering 22% of the island's total land area, and 60% of the area under cultivation (Table 2.1). Corn can be found planted in areas as steep as 100% in slope, often with little or no effort made to minimize soil erosion. These agricultural practices have, over time, subjected many interior portions of the island to heavy soil erosion (Vandermeer 1963), with the Department of Agriculture estimating that nearly 60% of the island's land area is suffering from moderate to severe soil erosion (DA 1985). Coconuts are the second most widely cultivated crop on the island, covering 9% of total land area and 24.7% of the area under cultivation (Table 2.1). Recent assessments of land use patterns on Cebu based on SPOT satellite imagery reveal that less than one-half of one percent of the island is forested, with this area consisting mainly of vestigial patches of open dipterocarp communities (World Bank 1989).

Besides the regions devoted to corn and coconut, and the limited area of natural forest, large portions of Cebu are categorized as having a "mixed extensive" land use pattern, and it is in these areas where we find that most woodfuel production is taking place. Covering 73,000 hectares (14.3% of total land area), the mixed extensive lands consist largely of secondary/shrub forest, cultivated area mixed with brushland, tree fallows, woodlots, and some agroforested lands. A failure to recognize the magnitude and importance of this ecosystem in sustaining Cebu's upland environment, as well as in producing significant quantities of woodfuels, is in large part responsible for the general perception of Cebu as an ecological disaster, and for categorizations of the island as a woodfuel deficit area. In fact, present land use patterns and the extent of forest destruction in Cebu are not new phenomena. Historical evidence suggests that as early as 1870 anywhere from 90 to 95% of Cebu's primary forests were already cleared for cultivation of corn and other crops (Ahern 1901; Vandermeer 1963; Roth 1983; Poffenberger 1990). From that time up until the present, most of Cebu's population has continued to rely on wood as a household cooking fuel, and there is evidence of a thriving commercial trade in woodfuels in urban areas of the province since at least the 1920s (Pendleton 1935; Spencer 1952; Bensel and Remedio 1993).

It becomes apparent then, that *current* woodfuel consumption patterns and the existence of commercial woodfuel markets in Cebu have little to do with the loss of primary forests on the island. It is also apparent that in the near total absence of natural forest cover, rural Cebuanos have developed alternative land use strategies capable not only of meeting the subsistence woodfuel needs of their families, but also for producing a marketable surplus for sale in urban areas. The following section discusses the most common woodfuel-producing land use systems and management practices used in Cebu; as well as the ways in which these systems and practices are influenced by social, economic and political developments in the region.

Woodfuel-Producing Land Use Systems and Practices

In order to examine the ways in which woodfuel-producing trees are grown and managed in Cebu, and the impact these practices have on the local environment and economy, exploratory rapid rural appraisal (RRA) surveys were conducted in eight different regions of the province (Figure 2.2), with each RRA visit lasting from three to five days (see Khon Kaen University

1987 for an introduction to RRA methods and principles). Sites chosen for study varied in terms of distance from the city, elevation, land use/ownership patterns and woodfuel production and management practices (Remedio 1993 gives a detailed description of the study sites). During the conduct of each RRA survey, guide questions were used to direct open-ended interviews with local government officials, rural woodfuel traders, landowners, wood-cutters, charcoal-makers and other local residents. The purpose of these interviews was, among other things, to gain a qualitative sense of how local people currently manage woodfuel resources, how these resources were managed in the past, what types of cropping and land use patterns are common in the area, who is involved in local woodfuel production and trade, why they participate, and what, if any impact government regulation of the woodfuel trade has on decisions to grow trees for sale in urban markets. In addition to the interviews, supplemental information was obtained from a variety of secondary sources, including a thorough enumeration of over one year's worth of woodfuel transport permits granted by the DENR in Cebu. These permits provide detailed information on the origin, destination, volume and species composition of each woodfuel shipment.

Based on oral histories related to us in both rural and urban regions of the province, there is evidence of a substantial commercial trade in woodfuels in Cebu going back to at *least* 1920. Much of the early trade appears to have centered around the harvesting of naturally-growing shrub and secondary forest species (such as *Vitex parviflora, Psidium guajava, Pithecellobium dulce*) in mountainous regions of central Cebu immediately west of Cebu City (Figure 2.2). However, intentional propagation of trees and shrubs for woodfuel production and other purposes was also practiced. For instance, MacDicken (1990) reports that Cebuano farmers developed a rotational agroforestry system of *Leucaena*, corn and tobacco as early as 1900, with *Leucaena* intentionally planted and maintained as a fallow crop, soil stabilizer, and source of green manure. Writing in 1935, Pendleton reported "plots and groves" of *Leucaena* and other planted species in the hillylands of Cebu City, as well as intensive cutting of a variety of trees for sale as fuelwood and timber. We encountered charcoal-makers in a mountain village 15 km northwest of the city who claim to have been using the same charcoal kiln, fed by the same tree fallow area of *Leucaena glauca* and *Gliricidia sepium*, for over sixty years (Bensel 1993).

Today, intentionally-planted tree and shrub species account for the largest portion of commercially-traded fuelwood and charcoal in the province. Based on our own observations, surveys of over 100 rural and urban woodfuel traders, and a review of all woodfuel transport permits issued by the DENR in Cebu over a 12-month period in 1991-92, the current species composition of commercially-traded woodfuels in Cebu City was estimated (see Table 2.2). Four varieties of fast-growing tree and shrub species account for 58% of the primary fuelwood (excluding coconut fronds and other non-woody biomass) and 71% of the charcoal sold in the city. All four species possess physical characteristics which have made them popular with Cebuano farmers. They are easy to establish, easy to harvest and split, they coppice extremely well, fix nitrogen (with the exception of *Cassia siamea*), provide high quality green manure and/or fodder for cattle and other ruminants, are tolerant of long dry spells and are generally well-suited to the topographic, soil and climatic conditions found throughout Cebu (NAS 1980; Davidson 1987). The second most important category of woodfuel-producing trees are fruit-bearing species, accounting for 23% of the fuelwood and 14% of the charcoal traded (Table 2.2). Naturally-growing secondary forest/shrubland species still account for 16% of the fuelwood and 12% of the charcoal traded (Table 2.2), despite the fact that in recent years the DENR has all but banned the cutting of these trees under most circumstances. Finally, lops and tops from high-value species grown in commercial reforestation and tree plantation sites also make their way into commercial woodfuel markets, meeting around 3% of urban fuelwood requirements and 2.4% of charcoal demand (Table 2.2).

Trees and shrubs are grown and managed in Cebu as part of a wide variety of land use and agricultural practices and for many different purposes. However, we've delineated six broad land use and tree management systems which produce woodfuels as either the primary output or as a by-product of other activities. Descriptions of each of these systems, including usual location, method of establishment, form of ownership and types of species found in each is provided in Table 2.3. An additional land use category not listed in Table 2.3 is lands planted to coconut or a crop/coconut combination. Covering over 45,000 hectares, or one-fourth of the area under cultivation, coconut lands produce abundant quantities of fronds, husks and shells which are estimated to meet over half of all rural subsistence biomass fuel demand in the province (Olofson *et al.* 1989), as well as 23% of residential and commercial sector demand in urban areas of Metro Cebu where they are traded as a commercial commodity (Bensel and Remedio 1993).

The single most important land use system in Cebu in terms of woodfuel production are tree/shrub fallow areas. Generally ranging in size from two to twelve hectares, tree/shrub fallows are a common form of land cover in many mountainous areas of central Cebu, and have reportedly been established since at least the turn of the century in a number of locations. Fallows are commonly found on very steep slopes which have gone in and out of corn cultivation over the years. In some cases, tree/shrub fallows are reported to have been intentionally established, but many respondents claim that these areas usually come about through spontaneous regrowth and expansion of adjacent fallows in the wake of agricultural abandonment. The most common pattern was for tree/shrub fallows to be under the ownership of absentee landlords or claimants, and managed by tenant farmers or local wood-cutters who contract with the landowner for harvest rights (Table 2.3). Off-site landlords we interviewed are motivated to keep their lands in a tree/ shrub fallow for a number of reasons. First, when fallowed their lands are not directly affected by land reform legislation covering areas planted to corn and rice. Second, these areas are often too steep, too far from water, and too distant from existing road networks to be used for cultivation of vegetables, cut flowers or other high-value marketable products. Finally, since the landlords were generally residing in urban Cebu, they could not be present to effectively supervise intensive uses of their land. Instead, these landowners were generally satisfied with sharing arrangements established with tenants or local wood-cutters, since this provided them with enough income to pay land taxes and since they were often holding fallow lands for speculative purposes.

Throughout rural and peri-urban areas of Cebu, smallholder farmers were found to be establishing and managing "backyard" woodlots usually ranging in size from 100 m^2 up to two hectares in area. Woodlots are generally established in marginal areas, or in fields not well-suited for agricultural production, but there were instances in which trees were planted on most available land as the primary "crop." The latter practice was often found to have resulted from the availability of off-farm employment opportunities. Household labor could be directed towards wage-paying jobs in the factories, retail stores and construction sites of Metro Cebu with tree-farming offering a non-labor intensive and flexible source of supplemental or emergency income. Smallholder woodlots are almost always intentionally established, and are managed to varying degrees of intensity depending upon the desired end-product (Table 2.3). Woodlots established to produce fuelwood and charcoal required the least attention, whereas trees planted for higher-value end uses, such as underground mine props, log bolts and lumber required more periodic pruning and maintenance in order to guarantee straight bole growth.

Indigenous and introduced agroforestry practices used in Cebu produce significant quantities of woodfuels for subsistence use as well as for market sale. Among the more common approaches encountered was the planting of *Leucaena leucocephala* in strips along field contours to control erosion, a sequential inter-cropping of coppiced *Gliricidia sepium* and corn, the planting and management of *Leucaena, Gliricidia,* and other tree species as boundary markers and live fencing, and a rotational fallowing of *Leucaena leucocephala* or *Leucaena glauca* with corn (and in some cases tobacco) similar to that reported in MacDicken (1990). Unlike pure stands of woodfuel-producing trees and shrubs grown in fallow areas or woodlots, trees incorporated into agroforestry systems are usually intended to provide multiple benefits — such as soil conservation, soil enhancement, fodder, fruit, building material — and are therefore managed on a more intensive basis (Table 2.3). The increased adoption of agroforestry practices by Cebuano farmers in recent years, largely in response to increased NGO and government extension efforts, has had the effect of improving agricultural practices, increasing vegetative cover in steeply sloping areas, and subsequently, increasing wood energy supplies in the province.

In addition to the intensively-managed agroforestry practices just discussed, substantial quantities of woodfuels are produced in Cebu from larger trees found singly or in clusters throughout coastal and upland areas of the province. Many of these trees are fruit-bearing — such as mango, star-apple, jackfruit, tamarind and avocado — and were planted mainly with that end in mind. Others were planted for shade or for decorative purposes (Table 2.3). Rarely are such trees felled solely for woodfuel purposes. Instead, fallen branches and trees uprooted in storms provide supplies of good quality fuelwood or are mixed with other species in charcoal kilns. As recently as November 1990, large numbers of fruit trees were uprooted by a typhoon that struck central Cebu, and were subsequently carved up for sale as timber, packing crate material and/or for woodfuels in the months following the storm. This incident resulted in what rural and urban traders described as a "glut", prompting the DENR to temporarily suspend the need to secure transport permits for woodfuels originating from this area.

Commercial tree plantations and reforestation sites can be distinguished from smallholder woodlots in terms of location, size and intensity of management. Plantations are usually established on better quality lands with access to water, and tend to be larger in size, generally ranging from five to over twenty hectares in area (Table 2.3). The primary motivation for establishing commercial tree plantations is to produce a variety of wood products for market sale, and so these areas are generally managed on a much more intensive basis than smallholder woodlots or fallow areas. Private plantations of *Leucaena leucocephala* and *Acacia auriculiformis* were encountered in Compostela and Carmen producing mainly woodfuel and underground mine props on a short rotation (2-5 years) basis, while larger corporate plantations set up under government-sponsored contract reforestation or industrial tree-planting programs were producing higher value wood products from species like *Gmelina* and mahogany on a longer rotation of eight to fifteen years. While commercial tree plantations are generally intended to produce timber and other high-value wood products, rural and urban traders alike claim that there is an increasing volume of charcoal and bulk fuelwood logs coming from the "lops and tops" of these operations.

Finally, as mentioned above, a portion of the woodfuels being traded in the commercial markets of Metro Cebu still originate from areas of secondary forest regrowth or shrubland. This is the case even though the DENR has placed much tighter restrictions on the harvest and transport of "naturally-growing" species, even banning the cutting of these species for a period in 1991-92. One factor responsible for continued woodfuel harvest from secondary forest sites is the strong preference among some urban consumers for fuelwood and charcoal produced from species commonly found in these areas. In particular, charcoal produced from *Vitex parviflora* (molave) is generally sold in urban markets at a price 20-30% higher than that of regular charcoal. These taste preferences, combined with the popularity of molave and other secondary forest hardwood species for rural home construction, woodcrafting and other end-uses (Table 2.3), has resulted in widespread over-cutting of these areas in many parts of the island. Since secondary forest areas generally take longer to regenerate relative to managed fallows or woodlots, larger stands of molave and other such species are now usually only found in isolated locations distant from the city and centers of population.

With the exception of woodfuel harvest from remaining forest regrowth areas, most of the fuelwood and charcoal sold in Metro Cebu is produced from planted species harvested on a rotational basis. Harvesting in tree/shrub fallows, woodlots, plantations and agroforested areas is almost always practiced on a rotational basis, with *coppiced* trees and shrubs being allowed to regenerate from the stump. The typical coppice rotation for species like *Leucaena* and *Gliricidia*, which make up 60-70% of the fuelwood and charcoal traded commercially (see Table 2.2), is around two years. In some cases, trees and shrubs in fallows or woodlots will be uprooted in order to facilitate a return to regular cultivation of food crops. However, it is far more common to allow these areas to regenerate, or for one or two crops of corn to be planted around coppiced stumps while trimmings and branches from the cut trees are placed in horizontal strips across the slope to control erosion. Overall, woodfuel management practices in Cebu appear particularly well-suited to the economic and environmental constraints faced by many farmers. The species most widely in use thrive even on the thin limestone soils and steep slopes found in most upland areas. Woodfuel management represents a far more benign form of land cover than the most widespread land use alternative, corn mono-cropping. And the most common woodfuel production practices require relatively little in the way of labor, capital and management — important factors given the presence of off-farm employment opportunities, lack of smallholder financial resources, and ownership of many fallow lands by off-site claimants.

Despite the apparent economic and environmental advantages of woodfuel management and production practices in rural Cebu, government officials in the province, and urban Cebuanos in general, still hold to the view that continued cutting of trees for fuelwood and charcoal is resulting in widespread environmental degradation. This view manifests itself in government restrictions on woodfuel harvest and transport, as well as in public discourse and debate carried on through the urban-based print and radio media. Recently, Cebu City government officials proposed banning the sale of charcoal in the city in order to halt deforestation, while a top-ranking official of the Catholic Church in Cebu urged upland farmers to "stop cutting trees", lest the resulting deforestation lead to landslides and depletion of the island's underground water supply (such admonitions are a regular feature in local newspapers). While Cebu is certainly suffering from a host of serious environmental problems, and there are anecdotal reports of underground wells drying-up or becoming increasingly saline, it is difficult to see how current woodfuel production and management practices contribute in any significant way to, or are the primary cause of, such problems. Indeed, the above discussion suggests that these practices may in fact help to *improve* the situation. The view that tree-cutting is the primary cause of Cebu's environmental woes stems from a fundamental misconception of the ways in which trees and shrubs are actually managed for woodfuels and other wood products throughout Cebu, as well as from an underlying urban bias against the ability of rural Cebuanos to manage local resources.

The fact that woodfuel resources in many areas have been managed for decades on a rotational basis, and that woodfuel and other wood product markets provide one of the strongest incentives for farmer tree-*planting*, tend to be overlooked. Likewise, the importance of woodfuel harvest and sale to the local economy has been almost completely ignored. Based on our estimates of the magnitude of commercial woodfuel demand in the province, we've calculated that the wood energy trade in Cebu is worth over 250 million Philippine Pesos (P), or US$10.1 million a year (Bensel and Remedio 1993). The actual contribution of the commercial woodfuel trade to local employment and income generation varies throughout the province, but in some areas of central Cebu it is clearly one of the major sources of cash income for a large percentage of the population. Given average production levels per wood-cutter or charcoal-maker (derived from Remedio 1991), we estimate that around 35,000 rural families, close to 15% of the rural household population, derive some cash income from the sale of fuelwood and charcoal in commercial markets. At least another 5,000 earn income as rural and urban traders, transporters and helpers in the trade. After accounting for the share of the trade accruing to traders, transporters and landowners, the fuelwood-cutters and charcoal-makers still receive around

P120 million (US$4.8 million), with the average family earning between P3,000-4,000 (US$120-160) a year, or approximately 60% of average annual cash incomes for upland farm families in these areas (CCHDP 1988).

In addition, woodfuel harvesting and conversion can be scheduled around other farm work or wage labor opportunities, providing a flexible source of cash income. Smallholders residing in interior portions of Consolacion were found to be holding regular factory jobs in nearby Mandaue City, returning to their farms on Saturdays and Sundays to harvest portions of woodlots earlier planted to *Leucaena*. Tenant cultivators in a mountainous region just west of Cebu City pass by shrub fallows of *Gliricidia* on the way home from their fields every day, cutting a few trees each time. Towards the end of the week the wood is sized, split, bundled and sold at a nearby *tabo* (weekly market), earning the family enough cash to purchase basic necessities like cooking oil and kerosene for lighting. Woodfuel harvesting and sale is also an important source of cash income for grain purchases towards the end of the dry summer months. Indeed, DENR officials in the southern municipality of Argao have occasionally adopted a hands-off policy on trade in small quantities of woodfuels, realizing that this is often the *only* source of cash income at certain times of the year.

Upland areas of Cebu Island have a long history of intensive settlement and cultivation, and natural woodlands in these areas were converted to other uses long ago. In place of natural woodlands, and partly in response to urban woodfuel demand, Cebuano hill farmers have propagated and managed a variety of tree and shrub species solely or in combination with other crops. Oftentimes, severe erosion on steep slopes left them little choice but to cease regular cultivation of food crops. In other cases, urban employment opportunities created a situation where tree fallows or woodlots provided a suitable ground cover and a flexible source of cash income. The nature and extent of these adaptations vary from one locality to the next, with actual land use patterns and practices resulting from a complex interaction of social, ecological and economic factors present in each place at a particular point in time. The conditions that combine to create these patterns are constantly changing, especially so in central Cebu due to increased land speculation and the general pace of economic development in the region. It is important to realize, however, that woodfuel production for commercial markets has formed an important part of land use practices in many parts of the province, helping to stabilize the environment in these areas while simultaneously providing an important source of supplemental income to local residents.

Commercial Woodfuel Trading and Distribution Systems

For most of the rural populace in developing regions of the world, fuelwood remains a subsistence commodity to be gathered freely from the surrounding environment. But in urban and peri-urban areas, fuelwood generally becomes a purchased (monetized) commodity, although supplemented in many instances by "freely-gathered" scrap wood and other intra-urban sources of wood energy. In the Philippines, it is estimated that 36% of all wood energy consumed is purchased in commercial markets, with the woodfuel trade providing income and employment to roughly 10% of the rural household population nationwide (DAP 1992). In Pakistan, the commercial woodfuel trade is reported to be a US$450 million a year industry, employing upwards of 100,000 people (Ouerghi 1993). And in India, woodfuel trading is said to be a source of income to as many as 4 million rural and urban inhabitants (Saxena 1993a).

With very few exceptions, commercial woodfuel markets in developing countries operate largely outside the purview of state management or control, representing something of a classic "informal" economic sector activity. This informal status, combined with what Soussan (1991) has called the "contrived illegality" that often surrounds woodfuel marketing activities, tends to result in negative perceptions of the woodfuel trade (and the people in it) among government officials, planners and aid workers (see Jamieson 1991 for a discussion of how widespread this tendency is in four Asian countries studied). As a result, commercial woodfuel markets are often viewed by officials in government as "backward" and inefficient (Goodman 1987), and it is widely assumed that such markets are monopolized by unscrupulous traders who exploit both rural woodfuel producers and low-income urban consumers. In contrast with these perceptions, case studies of commercial woodfuel marketing systems in a number of developing countries — including India (Alam *et al.* 1985a), Tanzania (Boberg 1991), Nigeria (Cline-Cole *et al.* 1990b), Haiti (Stevenson 1989), and the Philippines (Soussan 1991) — have generally found that the woodfuel trade is a well-organized, highly efficient and competitive industry. Rural and urban woodfuel traders are often found to play a critical and irreplaceable role in the functioning of the market, investing substantial quantities of financial and human capital into the purchase and transport of a commodity subject to seizure by forestry authorities, theft and other hazards (Leach and Mearns 1988; Godoy 1992).

The commercial woodfuel trade in Cebu suffers from many of the same negative perceptions just discussed. On numerous occasions we interviewed government and NGO officials who suggested that the woodfuel trade should be more tightly regulated, and that rural and urban traders should be replaced with either a government-run marketing system or a network of producer/consumer cooperatives designed to eliminate the allegedly excessive profits earned by the various intermediaries currently involved in the trade.

In order to examine the competitiveness and efficiency of the woodfuel trade in Cebu, as well as assess the desirability (and feasibility) of policy interventions intended to improve the situation, we investigated price and cost data related to all aspects of the woodfuel trade in rural as well as urban areas. Overall, more than 100 rural and urban traders were interviewed, as were wood-cutters, charcoal-makers, truck drivers and other actors involved in the trade (see Appendix A for an outline of the questionnaire used in surveying 81 urban woodfuel traders). As a result of differences in woodfuel harvest and conversion methods, distance from markets, number of intermediaries involved, and prices paid by different categories of end-users, we documented substantial variability in margins and profits earned by the different groups of participants in the trade. Therefore, the discussion below provides a description of a variety of processes by which woodfuels are cut, converted, transported, traded and sold in Cebu.

Throughout Cebu, the cutting of woodfuel-producing trees is managed by a well-established system of harvest and use rights. Smallholders growing trees in woodlots or in agroforestry systems will typically do their own harvesting. In the case of tree plantations and larger tree/shrub fallow areas, tree management and harvesting is accomplished either by tenants or local wood-cutters working on a sharing, contract, or daily wage basis. The most common sharing arrangement is for the tenant/wood-cutter to receive two-thirds of the farmgate value and the landowner one-third, although instances of sharing on a 50/50 basis were also encountered. In a contract arrangement, the landowner is paid a fixed sum of money, usually before harvesting, in exchange for the privilege of cutting all trees on a given piece of land. Contract arrangements are often facilitated by rural traders who have the financial capital to approach landowners with an advance cash payment. The trader will then usually propose a sharing arrangement with a wood-cutter, or hire cutters to harvest the area on a daily wage basis. Regardless of whether a contract or sharing arrangement is used, the final returns realized by each party tend to remain relatively consistent, reflecting an excellent understanding on the part of landowners, wood-cutters and rural traders of the resource with which they are dealing.

Depending on conditions at point of harvest, trees are either sized, split and bundled immediately, converted to charcoal on-site, or carried to another location for sizing and splitting or for charcoal-making. Generally speaking, two types of fuelwood bundles are produced, referred to by cutters and traders as *raja* and *ukay-ukay*. The *raja* bundles contain well-dried sticks of fuelwood that have been carefully sized and split, with the bark usually removed. In contrast, *ukay-ukay* or bulk bundles contain un-split or only once-split logs and branches, with the bark still intact and the wood still green. This wood is haphazardly bundled and shows large variations in the number of pieces and weight between bundles, unlike *raja* bundles which are consistently of the same weight and size. While *raja* bundles are typically marketed to residential consumers and small commercial establishments (at prices ranging from US$44-80/ton), *ukay-ukay* bundles are marketed to bakeries, noodle factories and other large-scale consumers (usually for around US$24-36/ton) who actually prefer the larger pieces for use in their ovens and boilers.

When charcoaling, tree poles are cut to a uniform size, with larger diameter pieces being split once. Depending on availability, charcoal-makers will mix irregular shaped fruit tree branches and/or roots and stumps with the straight sticks in order to increase output and fully utilize available wood resources. Most charcoal-making in Cebu is done in earth pit kilns with capacities ranging from 100-400 kg of finished product. Although no direct measurements were made, charcoal-makers in Cebu reported to us and to earlier investigators (Remedio 1991) conversion efficiencies of from 15-20% by weight, slightly higher than reported efficiencies in other areas of the Philippines (Hyman 1983a) but not inconceivable given the effort put into kiln construction, the experience of many charcoal-makers, and the close tending and monitoring of the carbonization process that is typical.

Supplies of fuelwood and charcoal are generally either delivered to a rural trader's home or left at a designated roadside drop-off point. The actual number of intermediaries involved in the rural woodfuel trading and transport network beyond that point varies between locations, with actual practices a function of such factors as distance from the city, road conditions, types of fuels being traded, and the degree of competition locally present. From the foothills just above Cebu City, smallholders, tenant farmers and landless wood-cutters carry down bundles of wood and sacks of charcoal which they display along the roadside or sell door-to-door, by-passing rural traders altogether (see Figure 2.3). At the other extreme, charcoal originating from interior mountainous regions of Tabuelan, 80 km north of Cebu City, often passes through as many as seven intermediaries (both rural and urban) before finally reaching consumers (Figure 2.3). More common is to have a single rural trader purchasing supplies of fuelwood and charcoal from smallholders and wood-cutters, securing necessary permits, arranging for transport, and then accompanying these supplies for delivery to urban wholesalers, retailers or direct to large-scale consumers (Figure 2.3).

Rural traders generally assume responsibility for securing the necessary permits from the DENR for a delivery of fuelwood or charcoal. The most fundamental regulation in force regarding woodfuel harvest and transport stems from DENR Administrative Order Number 26, which states that shipments of woodfuels and other wood products need to be accompanied by certification to the effect that the wood is originating from *planted* trees grown within *titled* or tax-declared private lands (DENR 1991b). Typically, traders will collect land titles or tax declarations from landowners where trees are being harvested, bring these to the DENR, complete the required paperwork and pay a sum of approximately P25 (US$1) for processing and documentation fees. Overall, the direct cost and effort involved in securing permits is usually rather minor, but for traders operating at a small scale it can be significant enough to warrant inclusion in any assessment of the profitability of the trade.

Rural traders are also responsible for making arrangements for transport. While some of the larger and more successful traders have been able to purchase their own vehicle(s), most depend upon hired transport. The types of vehicles in use range from passenger jeepneys with a maximum capacity of one to two tons, up to six-wheel drive cargo trucks capable of carrying anywhere from three to ten tons depending on the model and road conditions. Traders usually hire a vehicle for a fixed sum of money for a specified day of delivery, and as a result their main concern is to make sure that they can fill the conveyance with as much woodfuel as possible on that day in order to reduce per unit transport costs. It is therefore imperative that the trader coordinate with fuelwood-cutters and charcoal-makers to ensure that supplies are either delivered to the trader's home by the day of delivery or left along the road at specified drop-off points. In order to ensure an adequate supply of fuelwood or charcoal to fill the conveyance, it is usually necessary for rural traders to provide cash or in-kind advances to wood-cutters and charcoal-makers, often as far as three months in advance of actual delivery. It was not uncommon, therefore, to find rural woodfuel traders also operating a small store or grain-selling business from their residence, effectively bartering soap, cooking oil, rice and corn, medicine and school supplies for promises of future deliveries of fuelwood or charcoal.

Deliveries of woodfuels to urban markets or end-users are subject to inspection at DENR checkpoints. While the DENR mans only one permanent checkpoint along routes entering the city, they do field "roving checkpoints" on an irregular basis at a number of other major entry points. Problems arise when a permit understates volume shipped, if the permit is already expired, when non-authorized species are included in the shipment, and when no permit at all can be produced. Generally, the DENR is more tolerant towards the first two types of violations. However, in cases where no permit at all exists, or where unauthorized species are being transported (usually naturally-growing shrub or secondary forest species), the DENR has occasionally confiscated both the shipment and the conveyance used and held these until a hearing could be conducted. If the hearing goes against the trader, both the cargo and the conveyance can be forfeited to the government and sold at auction (DENR 1991b). Generally speaking, rural traders made little mention of ever receiving any undue harassment at the hands of DENR personnel manning checkpoints. Those who did have woodfuels confiscated agreed that they had violated regulations they knew and understood. In contrast, a number of rural traders in different parts of the province reported regular harassment at the hands of police and land transportation officials. Woodfuel traders coming from northern municipalities reported having to pay anywhere from P100 to P500 (US$4-20) in bribes to such officials every time they enter the city with a load, regardless of whether any violation actually occurred.

The degree of difficulty a rural trader encounters in disposing of a load will usually depend on how intensively potential buyers were canvassed in the days or weeks leading up to delivery. Some traders have long-standing arrangements with a few regular customers to deliver a certain amount of fuelwood or charcoal on a regular basis. Others will deliver on an order basis only. Still others will simply bring a load of woodfuels in and make the rounds of market areas and low-income districts to try and sell their product. In most cases supplies are left on consignment, with payment to be made at the time of the next delivery. Rural traders regularly complained that buyers in the city are never up-to-date on their payments, but that deliveries still have to be made in order to collect debts owed from previous transactions. This tendency, combined with the prevalence of rural traders providing cash or in-kind advances to wood-cutters and charcoal-makers, suggests that rural traders often have a substantial amount of financial capital tied-up in the trade at any given point in time.

An appraisal of the competitiveness of the woodfuel trading system in general, and the earnings of the traders in particular, should keep in mind the points raised above. In carrying out the activities necessary to deliver a load of woodfuels, a rural trader will typically be required to spend a significant amount of time as well as tie-up large amounts of financial capital in the process. In addition, an obvious element of risk is involved due to the quasi-legal nature of the trade and the frequency of non-payment of debts by customers. As a result, rural woodfuel traders typically need to possess both entrepreneurial know-how and a reasonable amount of financial capital. Many, but by no means all, are considered wealthy and powerful individuals in their own villages. This tendency helps to partly explain the perception that traders exploit wood-cutters and charcoal-makers, thereby becoming rich in the process. But this tends to confuse the facts. For the most part these individuals *entered* the woodfuel trade because they were already "rich", they do not necessarily *become* rich because they are involved in the trade. In fact, some traders claimed that they would prefer to give up the woodfuel trade and devote their time to other business pursuits, but that people in the area rely on them as an outlet for woodfuels and other wood products, as well as a source of cash or in-kind advances. Information obtained from interviews with wood-cutters and charcoal-makers generally support these claims, with many pointing to the advantage of not having to hassle with permits, transportation and urban buyers, even if they could earn larger *gross* margins by marketing woodfuels themselves.

Wood-cutters and charcoal-makers receive anywhere from 15 to 100% of the final selling price of woodfuels depending on whether they are cutting trees from their own lands and selling direct to consumers, or working on a sharing or daily wage basis. Rural and urban traders incur widely different expenses and earn a range of profits depending on how involved they become in arranging deals between landowners and wood-cutters, the transportation costs they face, the types of fuels being traded, and the customers to whom they sell. Six different cases of woodfuel production, transport, trade and marketing encountered during the course of field work are presented below in order to illustrate the complexity of the marketing process. In each case an effort was made to track the "flow" of woodfuels from rural producer through to urban consumer, collecting as much information as possible on price mark-ups and costs encountered at each stage in the process (see FAO 1991 for details of similar "wood flow" studies conducted in four Asian countries).

The six cases presented were chosen in order to provide something of a spectrum of woodfuel harvest, conversion and marketing activities. Figure 2.4 provides information on the approximate returns realized by the various intermediaries in each of the six cases discussed. Figure 2.5 presents an averaging of the percentage of the final selling price of fuelwood and charcoal earned by four groups of actors in the commercial woodfuel trade in Cebu, based on a review of all data collected during the course of our research.

The first case involves wood-cutters harvesting *Leucaena leucocephala* from a five hectare tree plantation in the town of Compostela (25 km north of Cebu City) as part of a sharing arrangement reached with the owner of the land. The trees are cut, carried to roadside, sized, split, dried and bundled with the resulting *raja* bundles weighing around 4 kg each. A woodfuel trader pays P3 (P25=US$1) per bundle to the plantation owner, with two-thirds of this to be given to the wood-cutters. This particular trader owns three different vehicles used for woodfuel and passenger transport, but other traders in the area would typically have to pay P1/bundle to have wood transported to the city. The fuelwood is delivered to the city and sold to urban traders for P4.50/bundle. Subsequently, urban traders were found to be charging P5 or 5.50 per bundle. Out of the final selling price of P5/bundle, the wood-cutters receive P2, the landowner P1, the rural trader P1.50, and the urban trader P.50. However, the rural trader's margin in this case should be adjusted downward by P1/bundle in order to account for the opportunity cost of the use of his own vehicle in transport.

Case 2 involves wood-cutters, working on a sharing arrangement, harvesting a mix of shrub, secondary forest and fast-growing species on idle lands also in Compostela. The trees are cut, hauled to the roadside, and sized into logs of 70-80 cm in length, with no effort made to split the wood, remove the bark, or dry it. The resulting logs and bulk (*ukay-ukay*) fuelwood bundles are purchased by a local trader for P1 each, with the average piece or bundle weighing around 2.5 kg each. One-third of the price paid goes to the landowner, the remaining two-thirds to the wood-cutters. A truck was hired by the trader for P900 to haul approximately three tons of fuelwood to a bakery in the adjacent municipality of Lilo-an, with the bakery purchasing the fuelwood on a weight basis for P800/ton. The significantly lower earnings received by the wood-cutters in this case reflect the relative ease with which bulk fuelwood logs and bundles are prepared.

The third case involves smallholders producing charcoal from trees growing on their own lands in remote interior portions of Tabuelan in northern Cebu. Due to the distance from a rural trader or passable road, smallholders in this area generally sell their charcoal to a "collector" for P25/sack, with the collector using money provided to him by a wealthy rural trader. The collector then uses animals and hired labor to haul the charcoal anywhere from 2 to 10 km to the residence of the rural trader, receiving P4/sack for this effort. Rather than transport this charcoal directly to urban markets, however, the rural trader in this particular case was found to be offering the charcoal on a consignment basis to other traders in the area who have formed themselves into a loose association. This group, consisting largely of female heads of farming households, lacks the financial capital to pay the collector for delivered supplies, or to offer cash or in-kind advances to charcoal-makers in return for promised deliveries. Instead, they rely on the first trader to accumulate enough supplies before hiring a vehicle to bring a load of charcoal to the city where, rather than sell the charcoal to urban traders, they unload their cargo at an outdoor market which operates for two days a week near the Provincial Capitol Building. For two days they camp out and sell charcoal for P55/sack to residential customers, restaurants and retailers in the area. At the end of the two day market period they return home by bus, pay the first rural trader P34 for each sack received, and the truck owner P8 for each sack transported, earning a gross margin of P13/sack for themselves, or about 24% of the final selling price.

Case 4 involves a hired wood-cutter producing charcoal from *Gliricidia* and *Leucaena* grown in a private woodlot in a hillyland area immediately west of Cebu City. A local trader purchases this charcoal for P40 a sack, with one-third going to the woodlot owner and two-thirds to the charcoal-maker. The trader pays P5/sack to have the charcoal delivered to urban wholesalers, where it is sold for P55/sack. Wholesalers then sell some of this charcoal for P60/sack to petty merchants in the area who will re-pack it into smaller cellophane bags. On average, one sack of charcoal will usually fill around 35 cellophane bags weighing .4 kg/each, and yield an additional 1-2 kg of fines and other residues which are either thrown away, given away, or sold to blacksmiths for P5-10/sack. The re-packed charcoal is sold 100 bags at a time for P2/each to small retail stores or ambulant charcoal vendors who, in turn, sell these for P2.50 each. When purchased in this fashion, charcoal is significantly more expensive than if purchased by the sack (P6.25/kg as opposed to P4/kg). However, the smaller bags are often preferred by households and food vendors because of convenience, ease of purchase and the limited budgets of many families.

Case 5 involves a smallholder harvesting his own woodlot of *Leucaena leucocephala* in *Barangay* Binaliw just north and west of Cebu City (a *barangay* is the smallest political unit in the Philippines). The trees are simply cut, sized and tied together into roughly equivalent bulk fuelwood logs and bundles. A local trader purchases these for P1 each, with an average bundle or log weighing around 3 kg. The trader pays P.50/bundle to have this wood transported to a factory producing mosquito repellent coils in nearby

Mandaue City, where it is purchased on a weight basis for a price of P600/ton, or approximately P1.80/bundle. The smallholder in this case claimed to be satisfied earning P.33 per kg of wood sold, even if he could potentially have earned up to P.85/kg for the same wood if he had split it, dried it and removed the bark. According to him, this takes too much time away from his regular farming activities and is basically not worth the effort.

Finally, case 6 involves the harvesting of a 2.3 hectare shrub fallow of *Gliricidia* in *Barangay* Sapangdaku in the foothills just west of Cebu City. A woodfuel trader reached a contract arrangement with the owner of the land to harvest the area in return for a P5,000 cash payment, an arrangement roughly similar to ones that they had reached a number of times in past years. The trader then hired four wood-cutters on a daily basis at a wage of P35/day plus one meal at noon. The wood-cutters worked for close to one month — cutting, sizing, splitting and bundling the wood into bundles weighing approximately 4.5 kg each. As these bundles became ready, two other men were hired to haul the wood ten bundles at a time to the trader's home, receiving P.50 for each bundle carried. The trader arranged to have the fuelwood delivered by jeepney a short distance to retailers in a residential area of Cebu City at a charge of P.50 per bundle. In all, the trader claims around 5,000 bundles were produced and sold for P4.00 each, grossing around P20,000. From that amount, P5,000 went to the landowner, around P6,600 to the wood-cutters and haulers, and P2,500 to transport. That left around P5,900 for the rural trader, less incidental expenses associated with making arrangements with the landowner and urban traders, securing permits and transportation, and providing meals to the wood-cutters and haulers. Urban traders subsequently sold this wood for P5/bundle, earning 20% of the final selling price.

From the above discussion it is apparent that there is no single system for woodfuel trading in Cebu. Instead, we find that woodfuel trading arrangements are varied and flexible, with the form actually taken depending on a host of factors particular to each situation. Figures 2.4 and 2.5 do show, however, that fuelwood-cutters and charcoal-makers typically earn from 30 to 50% of the final selling price if they work on a sharing basis, 40 to 60% if they are cutting trees from their own lands, and much less if hired on a daily wage basis. In the four cases involving a landowner, the percentage earned of the final selling price was consistently close to 20%. Owners of transport earned from 7 to 35% of the final selling price depending on distance to the city, road conditions, and the type of fuel being conveyed. Rural traders rarely earn more than 25% of the final selling price, usually only around 10%. Urban traders typically earned another 10-20% of the final selling price.

While the commercial woodfuel trade in Cebu is largely an informal sector economic activity, it does not appear to be inefficient or uncompetitive in its operations. Existing arrangements between wood-cutters and charcoal-makers, landowners, rural traders, vehicle owners, urban traders and consumers represent the product of decades of market development, intelligence and competition. A recent analysis of woodfuel marketing systems in the Philippines, undertaken as part of a World Bank-funded household sector energy strategy study, concluded that wood-cutters and charcoal-makers in the Province of Cebu receive substantially higher returns for woodfuels than their counterparts in other regions of the country (Soussan 1991). This difference is attributed to the relative scarcity of woodfuel supplies in Cebu. While it's possible that this may explain some of the difference, we are of the opinion that the higher margins earned by woodfuel producers in Cebu stems from the greater degree of competition among woodfuel traders in the province, as well as from the long history of rural experience and involvement in growing and managing trees and shrubs for sale in commercial markets. The commercial woodfuel trading network in Cebu represents an effective and efficient allocator of indigenous wood energy resources, providing income and employment to thousands of rural families in the province and an affordable source of energy to urban households and businesses.

Discussion and Conclusion

Official concern over deforestation and environmental degradation in the uplands of Cebu has formed the basis for a series of high profile, foreign-funded rural development programs undertaken in the province in recent years. Philippine government agencies like the DENR and the Department of Agriculture, as well as a number of local NGOs, also have programs to promote sustainable agriculture, agroforestry and reforestation in the uplands of the province. Discussions with officials and field personnel of these programs indicate that most view the commercial woodfuel trade as a problem that needs to be controlled through more restrictive regulation. It is our opinion that this perception derives from a failure to recognize the potentially beneficial ways in which woodfuel-producing trees are actually grown and managed in the uplands, and the social and economic rationale for these forms of management. For example, extensively-managed tree fallows, shrubland and woodlots are often described as "underutilized" land uses, which persist because of the "limited knowledge" of upland farmers for pursuing intensively-managed cash cropping of vegetables or cut flowers (CCHDP 1988).

As a consequence of these misperceptions, poor policy decisions are being made in two important areas. First, official regulation of the woodfuel trade in Cebu is both overly restrictive and highly ineffective, resulting nevertheless in clear disincentives for smallholders and other landowners to undertake tree-planting and management on a more widespread basis. Second, many of the agroforestry and reforestation approaches currently being promoted have failed to recognize the important influence that factors such as wood product markets and the presence of off-farm employment opportunities have on tree propagation and management decisions of farmers. As a result, these projects often overlook the potential for promoting smallholder tree-cropping as a commercial land use option in and of itself, and instead tend to advocate tree-planting by this group mainly for soil conservation and subsistence purposes, with commercial wood product demands to be met from trees grown on government and corporate plantations (DENR 1991a). Our research suggests that woodfuel and other wood product markets provide an excellent opportunity for more widespread promotion of tree-planting and management among small farmers, but that in order for this opportunity to be expanded changes are required both in the regulation of the woodfuel trade as well as in the design and implementation of agroforestry and reforestation programs in the province.

The primary objective of the DENR in regulating the commercial woodfuel trade in Cebu is to ensure that fuelwood and charcoal being produced and sold originates from *planted* (as opposed to naturally-growing) tree/shrub species grown on *titled* (as opposed to government-owned "timberland")[1] lands. On paper, woodfuel transport permits — officially known as "certificates of origin" — are to be granted on the basis of evidence of land ownership and actual site visits by DENR personnel, with these visits intended to determine the volume being shipped and to verify that the trees being cut are planted species growing on the applicants' land. In practice, due to a shortage of manpower and vehicles, site visits are only occasionally made. Instead, the DENR has adopted a *de facto* species-based enforcement system, allowing shipments of fuelwood and charcoal produced from commonly-planted species like *Leucaena* and *Gliricidia* to pass through checkpoints, while shipments of secondary forest species like molave are subject to much closer scrutiny. Transport permits are still required, however, although the issuance of a permit is now based almost entirely on the perceived veracity of the applicant and *some* evidence of land title or ownership.

This modified regulatory system is somewhat effective at stopping trade in illegally-cut species, and is certainly an improvement over earlier regulations which required a permit both for tree-*cutting* as well as for

[1] In the Philippines, lands are divided into two broad classifications, alienable and disposable (A&D) and "timberland", although in places like Cebu these classifications imply little in terms of actual land use. The determination of whether an area is A&D or timberland is based on the Revised Forestry Code of 1975 which claimed all lands of 18% or more in slope, and mountainous land over 600 meters, as part of public domain unless these lands were covered by legal claims obtained prior to that time. As a result, approximately 55% of the country's land area falls under the category of public domain timberland (Poffenberger 1990).

transport. However, and for a number of reasons, the regulatory framework currently in place tends to discourage more widespread tree-planting in the province, while simultaneously restricting competition in the woodfuel trade and introducing inefficiencies into the system. First, the issuance of transport permits is still based on evidence of land title, effectively excluding large numbers of untitled or tenant farmers from securing such permits. Second, the whole process of securing permits, while relatively inexpensive and straightforward, consumes enough time to discourage many from entering into woodfuel production and trade. Finally, relatively successful (in financial terms) woodfuel traders operating on a full-time basis have a much easier time securing transport permits under the current system than do part-time traders or smallholders who wish to transport their own wood (this tendency has also been noted in other parts of the Philippines, see Cruz *et al.* 1991).

A revised regulatory system based *solely* on a determination of species being transported, without the need for permits, has been proposed in detail elsewhere (Bensel and Remedio 1993, pp. 76-81). Such a system represents a total de-regulation of the transport and trade of *approved* (such as those found in the first and second categories in Table 2.2) tree and shrub species, to be enforced through the placement of DENR checkpoints at strategic entry points to the city, with exceptions being granted for "regulated" species (such as molave) on a case-to-case basis. This approach would have a number of advantages over the one currently in place. First, it would save the DENR financial and personnel resources currently devoted to issuing and validating certificates of origin. These resources could be redirected to training enforcement personnel in species identification, as well as towards focused efforts to halt blatant violations of forestry laws, such as poaching of timber species in private forest plantations and watershed protection areas. Second, a species-based enforcement mechanism would not discriminate against farmers growing trees on *untitled* lands, and might even encourage more sustainable agricultural practices among this traditionally marginalized group. Third, a clearly-articulated policy of allowing the harvest and transport of selected tree and shrub species would almost certainly increase incentives for all categories of farmers and landowners to undertake tree-planting on their property. Finally, de-regulating the woodfuel trade would serve to eliminate remaining barriers to entry that favor larger and more successful traders, enhancing competition and providing greater opportunities for smallholders to market their own wood products. While we recognize that any alternative regulatory system will also encounter problems and difficulties in implementation, we believe the above approach is a far better way for the DENR to achieve its protection objectives without simultaneously discouraging tree-planting on private lands. It makes no sense for the Philippine government to exhort agroforestry and reforestation, while simultaneously placing unnecessary and ineffective obstacles in the way of tree harvest, conversion, transport and marketing.

Among the dozens of rural development, social forestry, agroforestry and reforestation projects currently being undertaken in Cebu, few appear to have considered the possibility of promoting smallholder tree-farming *primarily* for producing for commercial wood product markets. Tree-planting and management *is* being promoted for soil conservation and soil enhancement purposes, as well as for fruit and fodder production. And the work of one NGO, promoting soil conservation practices in hillyland areas west of Cebu City, has been so successful that it is now used as a model for developing and implementing similar efforts in other parts of the Philippines and Southeast Asia. However, there appears to be little interest in the promotion of trees as a cash crop in and of themselves, even though many Cebuano farmers have already adopted such an approach on their own in recognition of the ease with which trees can be established, maintained, harvested and marketed. Likewise, some reforestation projects aim to replace "underutilized" tree fallows and shrubland with commercial tree species like *Gmelina* and mahogany, even though fallow areas produce abundant supplies of woodfuel from species like *Gliricidia* and *Leucaena*, with little expense or labor required on the part of the landowner in maintaining these areas. We do not wish to argue that woodfuel mono-cropping should replace agroforestry, or that fast-growing, short-rotation trees and shrubs should be *promoted* over longer-maturing, commercial species. Rather, we are suggesting that under certain conditions the former is often more appropriate to the natural conditions encountered in the uplands of Cebu, as well as to the land, labor and financial constraints faced by many upland Cebuano farmers.

What is required is a more flexible approach to agroforestry and reforestation extension work, as well as a greater appreciation for the influence that markets for wood products, labor and capital have on tree-planting and management decisions of farmers. Research done in the Philippines indicates that in the presence of markets for wood products, and in the absence of overly-restrictive regulation, farmers will adopt tree-planting and management almost as a matter of course (Wiersum 1982; Hyman 1983b; Olofson 1985; Durst 1987). And yet the DENR's Master Plan for Forestry Development (1990) is projecting the need for over 300,000 hectares of dedicated woodfuel plantations in order to meet just half of the 17 million m^3 fuelwood deficit expected by the year 2000. It is assumed that small farmers will not undertake tree-planting on any significant scale due to the opportunity cost of foregone food crop production. However, recent work suggests that in rural areas with highly monetized economies, like that in Cebu, it is the opportunity cost of *labor* not land that matters most in choosing among competing land uses (Hosier 1989; Arnold 1992; Godoy 1992).

In that case, non-labor intensive tree and shrub management for woodfuel production, such as that practiced by many Cebuano farmers, is an attractive land use option since it tends to maximize returns per unit of labor.

Agroforestry and reforestation approaches which are too capital-intensive, or that require too long a period before realizing returns, are also not likely to be widely adopted in Cebu. Smallholders and farmers with low incomes and/or uncertain tenure (conditions which tend to create higher personal discount rates) are more likely to prefer short rotation tree species that are easy and inexpensive to establish — and which provide income in a short period of time — over longer-maturing species like mahogany, even if the latter generates larger overall returns in the long run. Indigenous agroforestry practices, such as extensively-managed tree fallows and sequential inter-cropping of corn and coppiced shrubs, should be recognized as a logical and effective adaptation to local conditions, rather than be replaced with more intensive approaches that may produce higher returns per unit of land, but which require cash and labor inputs beyond the reach of many upland cultivators.

Any assessment of the longer-term supply/demand picture for woodfuels in Cebu needs to consider the very rapid social, economic and natural changes occurring in the province. As the island's population becomes increasingly urbanized, and as per capita incomes rise and alternative cooking fuels become more affordable and available, woodfuels will likely become less important in a *relative* sense. At the same time, the overall pace of population growth, combined with the continued presence of a substantial urban underclass, has in the past, and could in the future, continue to ensure that *absolute* levels of woodfuel demand remain fairly constant. If we acknowledge the potential for future economic downturn, or for a disruption in the supply of petroleum fuels due to internal or external conflicts, then woodfuel use could very well increase in the future in both an absolute *and* relative sense. Either way, it seems safe to assume that commercial demand for fuelwood and charcoal will remain substantial in urban areas of Cebu for some time to come.

Meeting this demand could pose problems if recent changes in land use patterns in the foothills west and north of the city are replicated over a wider area. The World Bank-funded Central Cebu Hillyland Development Program (CCHDP) has expanded and upgraded the road network in this area, with the stated purpose being to link farmers with urban fruit and vegetable markets and thereby encourage improved agricultural practices such as terraced vegetable gardening and fruit tree orchards. It is beyond the scope of this paper to comment on the degree to which such goals have been achieved. However, it became apparent during the course of our field work in these areas that new and upgraded road networks had also had the effect of making these areas more accessible to urban housing and commercial developers, thereby driving up local land prices, fueling land speculation, and disrupting longstanding landlord-tenant arrangements.

The net effect of these changes on the incomes and livelihoods of local residents is difficult to determine, with some clearly benefitting and others losing (see FARDEC 1991 for a critical discussion of this form of rural "development"). It appears probable, however, that the current pace and pattern of development in the interior of central Cebu will tend to *depress* woodfuel production in the region. This is the case for a number of reasons. First, in mountainous areas just west of the city, widespread tree and shrub fallows are being replaced with middle- and upper-class housing subdivisions, which are in growing demand because of the views offered and the increasingly congested conditions found in the city. Second, in more interior regions, road expansion and upgrading has facilitated conversion of agricultural lands to golf courses, and the replacement of subsistence cropping systems with commercial vegetable gardening. While these developments certainly hold the potential to better the lives of local residents, they tend to reduce the production of woodfuels from the area.

If woodfuel production declines in upland areas of central Cebu it would not be unlikely to assume that over time farmers in areas further to the north and south would step in to fill any gap. The long history of growing and managing trees and shrubs for sale in commercial woodfuel markets in the province suggests that Cebuano farmers are fully capable of adapting to changing market conditions. Government planners, regulators, and other officials would do well to recognize this market intelligence as a means to promote more sustainable land use management practices in the province, and modify existing regulations and programs to more fully exploit this potential. In the end, improving the income and living conditions of upland Cebuano farmers, as well as those of other rural Filipinos, could go a long way towards reducing pressure on existing forested areas in the islands of Mindanao and Palawan, as well as towards easing some of the unmanageable urban sprawl occurring in cities like Manila and Cebu.

Table 2.1: Economic, social and environmental characteristics of Cebu Province, Philippines

1990 Population	2,646,517; 52.4% urban, 47.6% rural
Total Land Area	509,000 hectares; 5,090 km^2
1990 Population Density	520 persons/km^2 (national average is 202 persons/km^2)
Topography	24.1% of land area in 0-18% slope category; 42.3% in 18-30% range; 21.7% in 30-50% range; 11.9% over 50% in slope
Major Agricultural Crops	111,853 hectares planted to corn (22% of total land area, 60% of area under cultivation); 45,651 hectares devoted to coconut *plantations* (9% of total land area, 24.7% of area under cultivation); other crops include rice (7,366 hectares), banana (6,353 hectares), fruit trees (3,620 hectares), sugar cane (3,515 hectares), root crops (3,235 hectares), legumes/peanuts (1,440 hectares), and commercial vegetables (1,101 hectares)
Other Land Uses	mixed extensive (73,000 hectares), grassland (6,000 hectares), mangrove swamps/fishponds (3,000 hectares), open Dipterocarp forest (2,000 hectares)
Climate	average annual rainfall of 1,638 mm (64.5 inches); minimum monthly rainfall of 50.4 mm (March-April), maximum of 206.5 mm (October-November); mean temperature range of 26.4-28.7° C; minimum temperature of 22.6°C, maximum of 33.1°C
Economy	Cebu City is the second largest urban/industrial region in the country; international air and seaport; major industries include banking and other services, coconut oil, activated carbon, copper concentrate, electronics, furniture, carrageenan and handicrafts; 42.4% of families in the region living below government-set poverty threshold of US$ 294/household/year

Sources: PPDS 1987; World Bank 1989; PPDO 1990; FARDEC 1991; NSO 1992; NSCB 1993

Table 2.2: Species composition of commercially-traded woodfuels in Cebu City, 1991-92

Local/Common Name	Scientific Name[1]	Percent of Total: Fuelwood	Percent of Total: Charcoal
Fast-Growing Trees and Shrubs			
Biateles/Giant ipil-ipil	*Leucaena leucocephala*	32.6	29.3
Madre de Cacao/Kakauati	*Gliricidia sepium*	17.1	27.9
Kabahero/Native ipil-ipil	*Leucaena glauca*	7.0	12.0
Robles/Yellow cassia	*Cassia siamea*	1.3	1.7
Fruit-Bearing Trees			
Manga/Mango	*Mangifera indica*	7.4	5.1
Caimito/Star-apple	*Chrysophyllum cainito*	4.7	4.1
Lomboy/Java plum	*Eugenia cumini*	2.2	0.3
Nangka/Jackfruit	*Artocarpus integra*	2.1	1.5
Sambag/Tamarind	*Tamarindus indica*	1.9	1.0
Santol	*Sandoricum koetjape*	0.8	0.4
Abocado/Avocado	*Perseas americana*	0.6	0.9
Other fruit species		3.2	1.1
Secondary Forest and Shrubland Species			
Anan/Balinghasai	*Buchanania arborescens*	4.1	-
Bayabas/Native guava	*Psidium guajava*	2.2	0.9
Tugas/Molave	*Vitex parviflora*	-	6.3
Kamanchilis/Man. tamarind	*Pithecellobium dulce*	1.7	0.3
Bagalnga	*Melia dubia*	0.9	-
Malatamban	*Cyclostemon bordenii*	0.8	0.4
Dita	*Alstonia scholaris*	0.5	-
Agoho	*Casuarina rumphiana*	0.3	-
Cha	*Ehretia microphylla*	-	0.5
Other sec. forest species		5.6	3.3
Commercial Reforestation Species			
Mahogany	*Swietenia mahogoni*	2.0	1.5
Gmelina/Yemane	*Gmelina arborea*	1.0	0.9
TOTAL		100.0	100.0

1. Determination of scientific names based on Merrill (1926) and Salvosa (1963)

Table 2.3: Characteristics of woodfuel-producing land use systems in Cebu Province

Land Use System	Usual Location	Range of Sizes Encountered	Method of Establishment	Ownership/Management Practices	Most Common Species	End Uses
Tree and Shrub Fallows	Steep, badly eroded hillsides, abandoned plots	2-12 hectares	Spontaneous regrowth, cuttings, broadcast of seeds	Absentee landlords/ extensively managed by tenants, wood-cutters	*Gliricidia sepium, Leucaena glauca*	Charcoal, fuelwood
Smallholder Woodlots	Near households, along roads, on abandoned fields	0.1-2 hectares	Intentionally established from cuttings, seeds or seedlings	Smallholders/extensive management (fuelwood species), intensive management (high value species)	*Leucaena leucocephala, Acacia auriculiformis, Gmelina arborea*	Charcoal, fuelwood, underground mine props, high value wood products
Agroforestry Systems	Within and among the agricultural landscape	non-contiguous	Intentionally established	Smallholders/intensive management	*Leucaena leucocephala, Gliricidia sepium,* fruit-bearing species	Fuelwood, charcoal, fodder, green manure, shade, live fencing, soil conservation
Isolated/ Scattered Trees	Around homes, along roads, field edges	non-contiguous	Intentionally established	Smallholders, landowners/intensive management for some fruit species (mango), extensive management for shade, decorative, other trees	*Mangifera indica, Artocarpus spp., Tamarindus indica, Perseas americana, Chrysophyllum cainito*	Fruit, shade, charcoal and fuelwood from fallen branches and storm-damaged trees
Commercial Tree Plantations/ Reforestation Sites	Better quality (flat) lands near roads and water source	5-20 hectares	Intentionally established	Larger landowners, contract reforestation projects, private companies/intensively managed by tenants or laborers	*Leucaena leucocephala, Gmelina arborea, Swietenia mahogoni, Acacia auriculiformis*	Timber, high value wood products, underground mine props, fuelwood and charcoal (from lops and tops)
Shrub/ Secondary Forest Areas	Isolated, remote areas, distant from urban center	0.5-15 hectares	Spontaneous	Absentee owners, public lands, common lands/ extensively managed	*Buchanania arborescens, Vitex parviflora, Pithecellobium dulce, Psidium guajava*	Fuelwood, charcoal, lumber for home construction, woodcrafting, tool handles, fruits, medicine

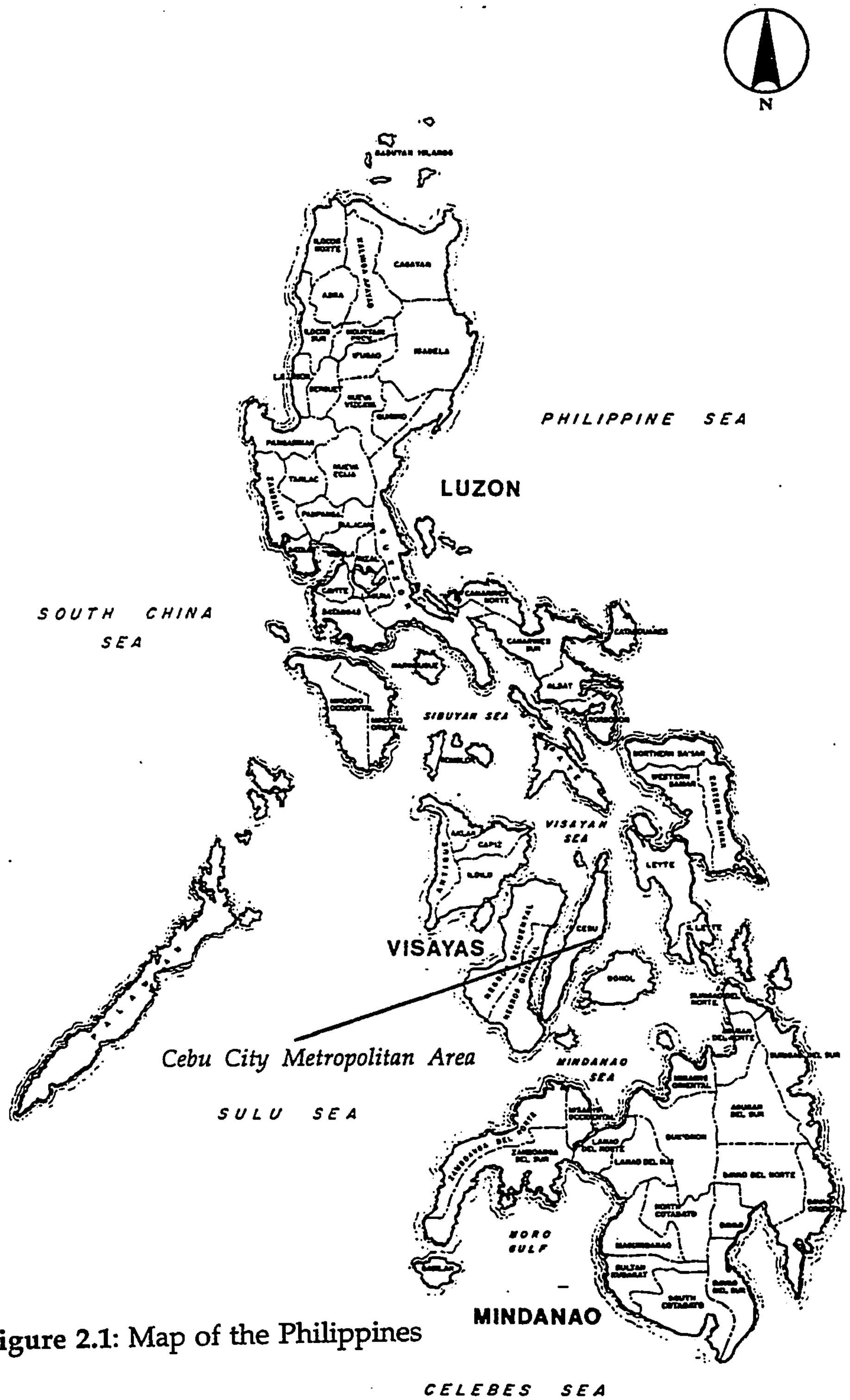

Figure 2.1: Map of the Philippines

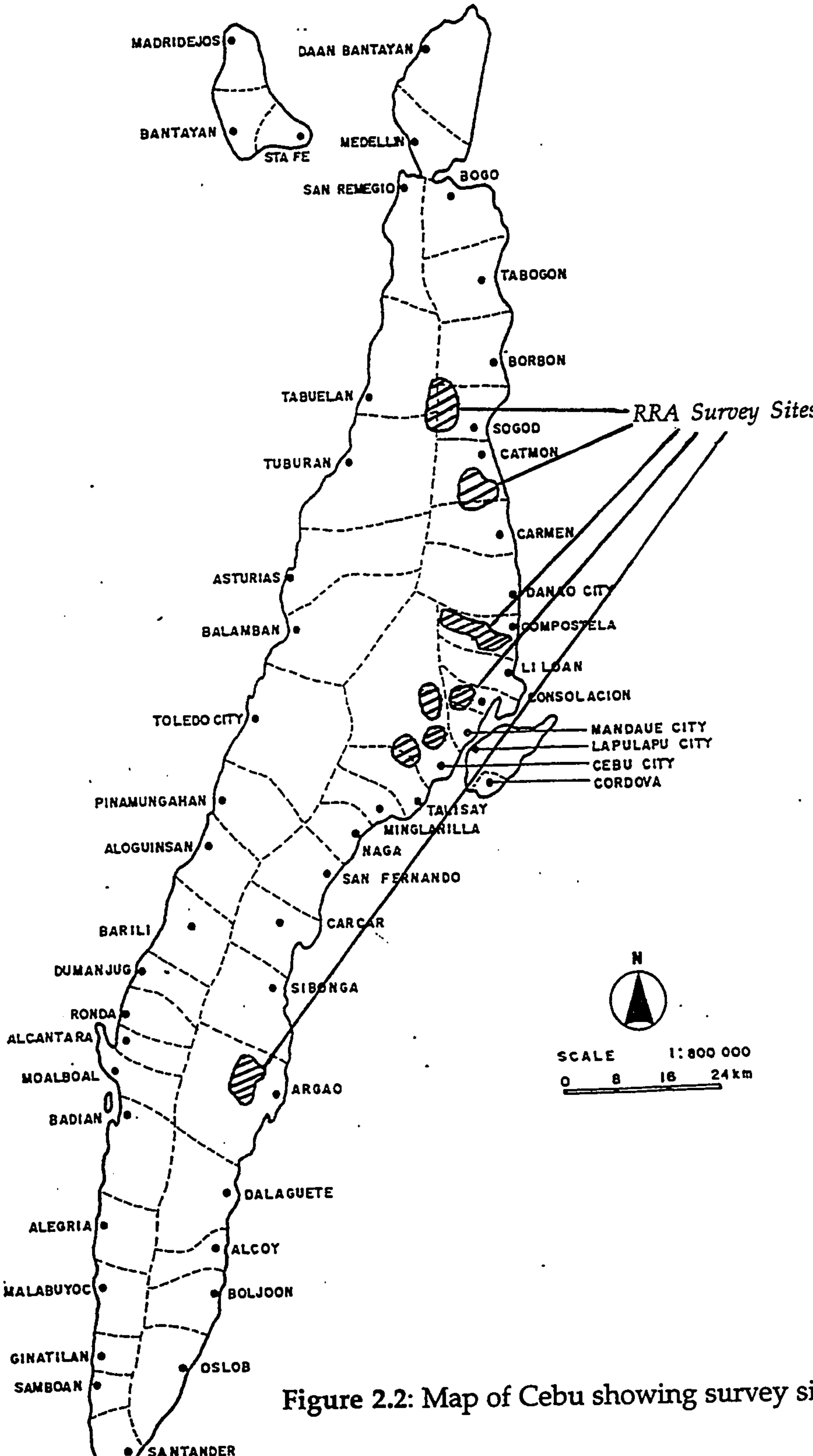

Figure 2.2: Map of Cebu showing survey sites

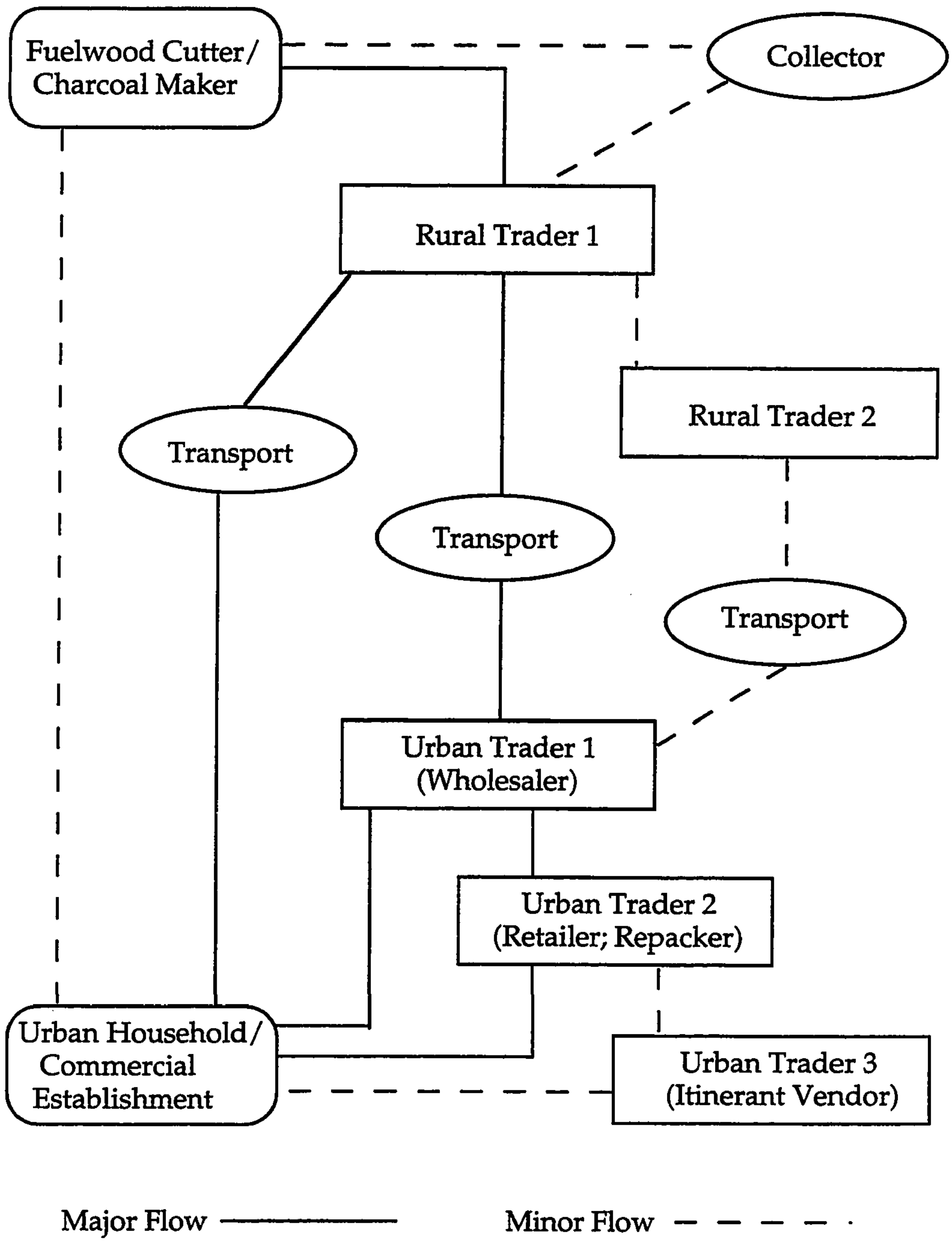

Figure 2.3: Schematic diagram of woodfuel flows in Cebu

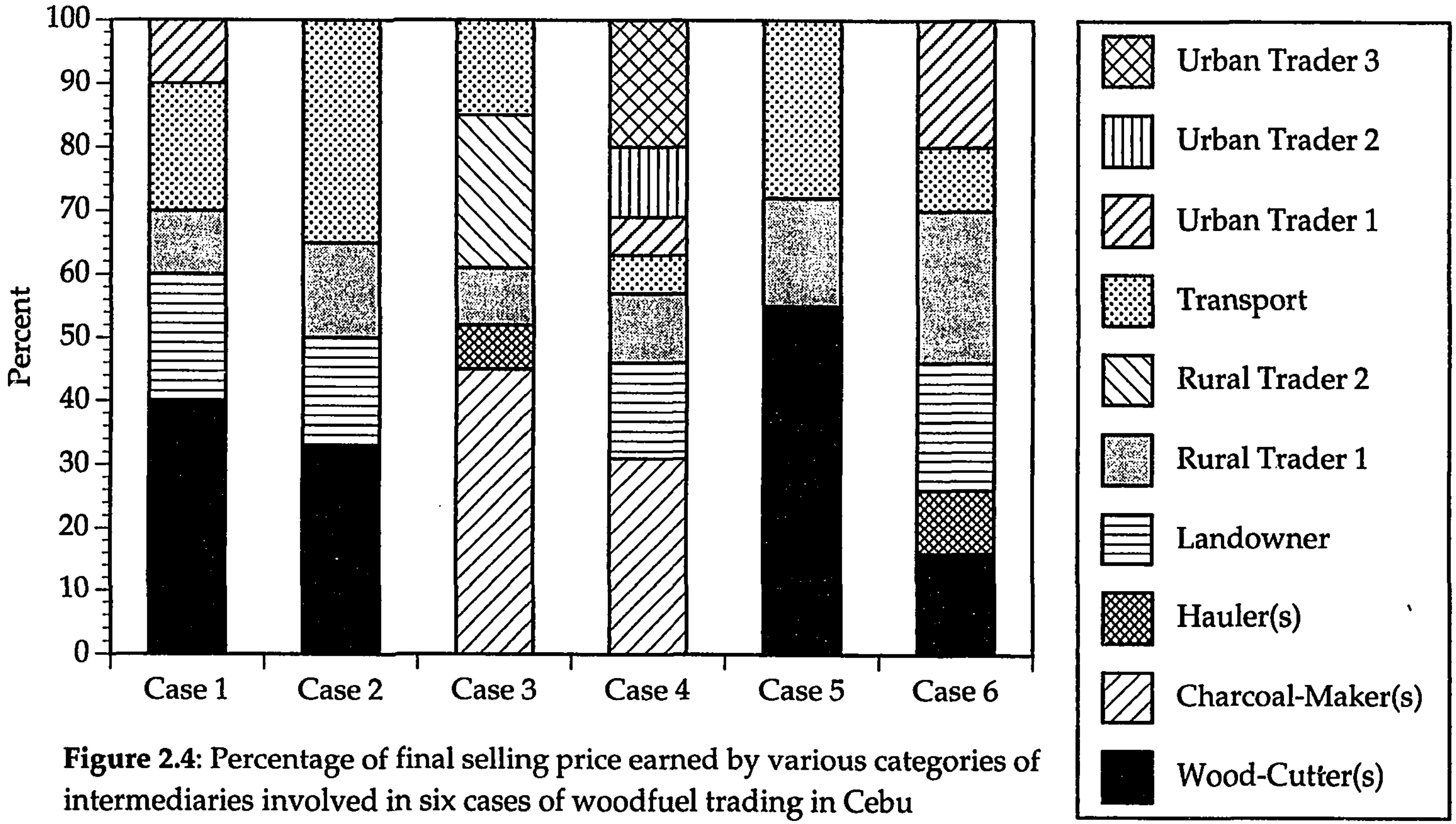

Figure 2.4: Percentage of final selling price earned by various categories of intermediaries involved in six cases of woodfuel trading in Cebu

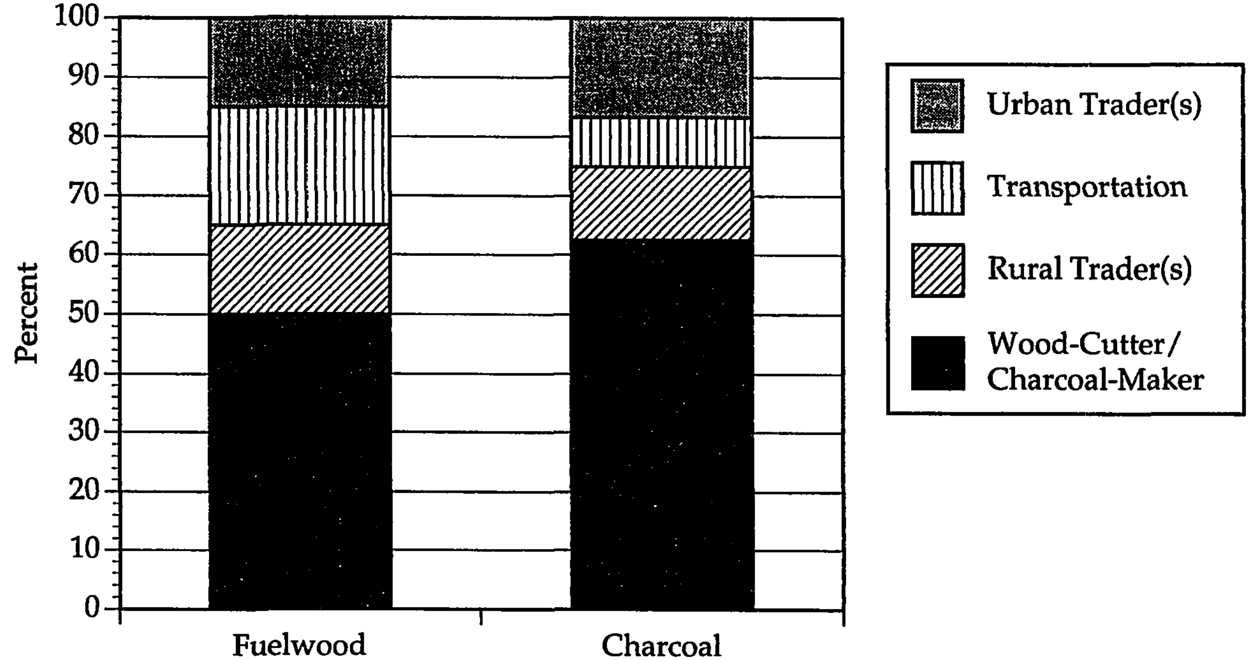

Figure 2.5: Average percentage of final selling price earned by each group of intermediaries in the woodfuel trade[1]

1. Wood-cutters and charcoal-makers working on others' land typically share from one-third to one-half of their returns with the landowner.

CHAPTER 3

RESIDENTIAL ENERGY USE PATTERNS IN CEBU CITY, PHILIPPINES

Introduction

Population growth, rural-urban migration, and high rates of urbanization are combining to make the developing world's population increasingly urban (Preston 1988). In 1990, one-third of the people in developing nations resided in urban regions, by the year 2000 this figure is projected to increase to 40%, and by 2020 it's expected to reach 54% (Keyfitz and Flieger 1990). By the end of this century, two billion people will be living in developing country urban areas, and 43 of 59 cities in the world with populations exceeding 5 million will be located in these countries (Ghosh 1984; Keyfitz and Flieger 1990). The rapid pace and extent of urbanization in developing countries generates fundamental changes in energy and material use patterns, as well as in the composition and concentration of pollution and waste flows (D.W. Jones 1989; Leitman 1991). Improved understanding of urban energy systems is an essential requirement in assessing the local, regional and global environmental impacts of urbanization and urban energy use, as well as in designing policies and technologies which can help to mitigate these impacts while ensuring adequate supplies of energy to sustain development.

This paper presents the results of a comprehensive survey of residential sector energy use in the second largest urban center in the Philippines, the Cebu City metropolitan area (population 1.1 million). A total of 603 households in the 49 urban *barangays* (a *barangay* is the smallest political unit in the Philippines) of Cebu City were interviewed from February to May 1992 regarding their energy purchase and utilization patterns. The primary objectives of this survey were to: 1) quantify residential sector consumption of fuelwood, charcoal, kerosene, liquefied petroleum gas (LPG), electricity and other household fuels, and; 2) determine the major social, economic, cultural and environmental factors that are driving current fuel-choice and fuel-use patterns in the residential sector. Details of survey design and implementation — including determination of sample size, respondent selection, questionnaire design, and interview methods — can be found in Appendix B. An outline of the questionnaire used in the survey is provided in Appendix C.

A careful analysis and quantification of residential sector energy use patterns in developing country cities like Cebu is important for a number of reasons. First, in recent years Metro Cebu has experienced rapid economic and population growth, and within the Philippines is looked to as a model for development of medium-sized cities (those with populations of from 100,000 to 1 million) and urban conglomerates. Periodic shortages of electric power and other forms of energy have, however, been cited as a limiting factor in Cebu's economic development (Churchill 1993), prompting the World Bank and other development agencies to extend assistance for a number of energy-related projects in the region, including the interconnection of Cebu's electric power grid with geothermal power plants located on the nearby islands of Leyte and Negros (see Figure 3.1). Annual increases in electricity demand of from 9.2 to 11.4% have been common in Cebu in recent years (NPC 1991), with evidence from the rest of the country and Southeast Asia suggesting that the residential sector is likely responsible for the largest portion of this increase (Meyers *et al.* 1990; UNDP/ESMAP 1992). Second, there is widespread concern among local and provincial government officials that continued high levels of urban fuelwood and charcoal demand may be having serious negative impacts on Cebu's rural environment, although research conducted as part of this study, and presented elsewhere, suggests that this may not actually be the case (see Bensel and Remedio 1993). Finally, since the Philippines is currently dependent on imported oil for approximately 70% of all its commercial energy requirements, any substantial increase in the pace or extent of fuel-switching in the residential sector may have serious consequences for the nation's balance of payments and energy security. Therefore, a detailed investigation of residential sector energy use patterns in

Cebu City can be valuable for both local and national energy planning and policy-making. To the extent that Cebu is representative of a pattern of economic development in "non-capital" or peripheral urban regions of Southeast Asia — such as Chiang Mai, Thailand or Penang, Malaysia — lessons learned from this study can also be of use elsewhere.

The focus of this paper on *residential* sector energy use is dictated by a number of considerations, none of which are necessarily unique to Cebu. First, in most developing countries the residential sector is the largest consumer of energy, typically accounting for anywhere from 30% to over 90% of total energy consumption on an input basis (Leach and Gowen 1987; OTA 1992). In the Philippines, the residential sector accounts for almost half of total energy consumption, as well as for one-third of all electricity use (UNDP/ESMAP 1992). Second, residential sector energy use patterns are known to change rapidly in response to urbanization-induced variations in lifestyle and settlement patterns, as well as in response to changes in household income, fuel prices and fuel availability (Sathaye and Meyers 1985; Soussan *et al.* 1990; Fitzgerald *et al.* 1990; Sathaye and Tyler 1991; Barnes and Qian 1992). Jones (1989) estimates that a 1% increase in urbanization will increase per capita energy consumption by anywhere from 0.35 and 0.48%, implying that independent of absolute increases in population, the demographic shift from rural to urban areas will tend to increase overall energy use. Meyers *et al.* (1990) report that from 1980-88, residential sector electricity demand grew at annual average rates of between 7 and 17% for nine Asian countries studied, with rapid urbanization cited as a major factor in this increase. Sathaye and Tyler (1991) illustrate how factors such as increased city size and the growing participation of women in the formal sector workplace can lead to widespread changes in patterns of cooking fuel usage in the residential sector, characterized primarily by a shift from traditional biomass fuels towards more compact, clean and convenient forms of energy such as LPG and kerosene.

Despite the importance of the residential sector in overall energy use, and the potential for rapid change in both the quantitative and qualitative aspects of energy demand in this sector, relatively little is understood of how households procure and consume various types of energy in developing country urban areas, and how fuel-choice and fuel-use patterns are affected by economic, social, cultural and other factors present in any given city. This paper will contribute to that body of knowledge by examining household energy use patterns in a rapidly urbanizing setting. The next section provides a brief review of recent economic and demographic trends in Cebu City in order to set the context for a discussion of household energy use. After that, the major findings of the household energy survey are presented, focusing on three important areas: residential sector consumption of four major cooking fuels (fuelwood, charcoal, kerosene and LPG), the importance of fuel-switching trends on household cooking fuel use, and residential sector electricity use patterns. A concluding section highlights the major findings of the paper and discusses the relevance of these findings to energy sector planning and policy-making in Cebu, as well as for other urban areas in the Philippines and the developing world.

The Study Site

Cebu City is the capital of the island province of Cebu, located 550 kilometers south-east of Manila in the center of the Visayan Island region (Figure 3.1). Cebu City had a 1990 population of 610,417 (NSO 1990). The broader Cebu City metropolitan area, including Cebu, Mandaue and Lapu-Lapu Cities, as well as two adjacent municipalities, had a 1990 population of 1.1 million. Since 1980, the population of Metro Cebu has grown at an average rate of 3.1% per annum, compared with rural population growth rates in the province of 1.9%/annum and the national average of 2.3%/annum (NSO 1992; NSCB 1993). Overall, 52.4% of the population of Cebu Province resides in urban areas, compared with the national average of 42.7%.

The Cebu City metropolitan area is the second largest urban center in the Philippines after Metro Manila, serving as the commercial, industrial and transport hub for the rest of the Visayas and the southern island of Mindanao

(Figure 3.1). Due to its status as the center of government opposition during the presidency of Ferdinand Marcos, Cebu was largely neglected by the government throughout much of the 1970s and 80s, receiving the lowest national expenditure per capita of any province in the country, and paying up to ten times more in taxes than it received in national government spending (Churchill 1993). Since 1987, however, Metro Cebu has witnessed rapid economic growth, with some economic indicators pointing to growth rates as high as 15% per annum in recent years (Tiglao 1991; RDC 1993). Local government officials and business leaders tout Cebu as the next "tiger economy" of the Asia/Pacific region, and refer to the expansion of economic activity in the region as "Ce-boom" (PPDO 1990). Future development plans for the city and province are based primarily on an expansion of industrial and manufacturing activity, including an increase in the number and size of special industrial zones and export processing zones (EPZs) in various parts of the island (RDC 1993). Continued upgrading and improvement of Cebu's infrastructure, and expansion of the island's international air and sea port facilities, will likely strengthen Cebu's status as the premier city and commercial and trading center of the southern Philippines.

The relatively rapid pace of economic development in the Metro Cebu region has, however, also served to attract an increasing number of migrants from rural areas of the province, as well as from surrounding islands. This influx is threatening to overwhelm new job creation (Sino-Cruz 1992), and is straining already inadequate infrastructure and social services in many parts of the city (Churchill 1993). Rapid urban population growth and rural-urban migration are worsening the crowded conditions found in Cebu's low-income squatter districts. Basic services in these areas — including water, sewage, waste disposal and power — are sorely lacking, and their absence is believed to contribute to relatively high rates of infant mortality and morbidity in these communities (Gultiano 1992). Traffic congestion, crime, solid waste problems, air pollution, water pollution, and power shortages are also on the rise, complicating official development plans and prompting many native Cebuanos to complain that their city is rapidly becoming "just like Manila."

In the midst of the rapid economic and demographic transitions currently underway in Metro Cebu, changes are also occurring in the ways households procure and consume energy in the city. Economic expansion has bolstered the size and purchasing power of Cebu's middle-class, enabling more households to purchase kerosene or LPG cooking stoves, as well as a variety of electric appliances and devices. There are indications that the increased participation of female heads of households in the formal sector workplace is also leading to wider use of more convenient cooking fuels like LPG. Increasingly dense settlement patterns also favor more compact and clean cooking fuels over bulky (and smoky) fuelwood. Households unable to afford kerosene or LPG stoves were found to be purchasing a significant portion of their meals from prepared food vendors, perhaps to minimize fuelwood use — and associated problems with smoke — in their household. Finally, increasing urban size and population density tends to improve the economics of LPG and kerosene transport and marketing systems, resulting in increased availability of these fuels at lower prices.

Residential Sector Energy Use

Energy consumption in the residential sector represents approximately 45% of overall energy use in developing countries of the world, accounting for as much as 59% of the total in African developing nations (OTA 1992). This consumption includes high rates of biomass fuel use on a relatively inefficient basis in rural regions. But even in highly industrialized and urbanized settings, such as Delhi, India, the residential sector can still account for upwards of two-thirds of total energy use (Leitman 1991). The largest portion of residential sector energy use in developing countries goes towards food preparation. Cooking fuel consumption accounts for 85% of residential sector energy use in Brazil, 91% in India, and 97% in Kenya (OTA 1992).

Economic development and increased urbanization can, however, serve to alter these shares, with electricity use for lighting and appliances making up a larger portion of household energy consumption. Rapid growth in residential sector electricity demand, such as the 10-15% annual increases currently being experienced in a number of Asian developing nations, poses serious problems for developing country utilities. Besides the need to add new capacity to simply keep up with growing demand, residential sector electricity use is characterized by large peaks during morning and evening hours, complicating load management and necessitating the installation and use of relatively expensive peaking power facilities (Meyers *et al.* 1990; Schipper and Meyers 1991).

The highly dispersed nature of the residential sector makes close monitoring of household energy use in these countries difficult. The discussion below will focus on three major aspects of residential sector energy use in Cebu City at a *specific point in time,* with reference made to historical data when available. While the results presented represent a detailed and accurate "snapshot" of household energy use in Cebu, it should be kept in mind that residential sector energy use in urbanizing areas can change rapidly, and in response to a host of factors. The importance of this study in establishing a baseline understanding of household energy use patterns in 1992 then becomes apparent. The first section discusses the most widely-used cooking fuels in use in the residential sector of the city — namely fuelwood, charcoal, kerosene and LPG — focusing on the percentage of households using each, amounts used, reasons for using and levels of consumption. This is followed by a discussion of current fuel-switching trends in the residential sector, and how this might impact on the types and amounts of energy used in the residential sector. The final section analyzes residential sector electricity use, and the important role that income growth and urbanization can have on household electricity demand.

Cooking Fuels

Table 3.1 presents a breakdown of *primary* cooking fuel use in Cebu City households based on income. Figure 3.2 presents the same information in a graphical manner. It is immediately apparent from Table 3.1 and Figure 3.2 that household income plays a major role in determining fuel-choice decisions in the residential sector. Nearly three-fourths of households in the lowest income category are dependent on fuelwood or charcoal as their primary cooking fuel, while over 80% of households in the highest income category rely on LPG for the bulk of their cooking energy requirements. Kerosene is evidently a transition fuel, increasing in usage among households in the lower-middle and middle income categories, then sharply declining in importance after that.

While the data in Table 3.1 and Figure 3.2 clearly represent household preferences for *primary* cooking fuels, it does not account for the widespread practice of multiple cooking fuel usage among households in all income categories. Table 3.2 presents the percentage of households using each of the major cooking fuels at least part of the time, whether that usage be for primary or secondary purposes. Whereas charcoal is used as a primary cooking fuel by only 5.6% of the residential sector (Table 3.1), this fuel is used on a supplemental or backup basis, or for fuel-specific cooking activities (such as grilling meats and fish), by 71.8% of the households in the city (Table 3.2). Table 3.2 also shows that fuelwood is used by even the highest income households (13.2%) on at least a supplemental basis. The tendency towards multiple fuel usage can also be observed by analyzing stove or cooking device ownership patterns. Figure 3.3 shows the percentage of households in each income category owning different kinds of stoves or cooking devices. Households in all income categories were generally found to own and maintain a number of different kinds of cooking devices in order to be able to cook extra foods, prepare fuel-specific dishes, and to have a backup in case the preferred cooking fuel became unavailable at any time.

Fuelwood. Fuelwood is used as the primary cooking fuel in 31.8% of Cebu City's households, and at least some of the time in 45.9% of the total (Tables 3.1 and 3.2). Residential sector fuelwood consumption in the 49 urban *barangays* of Cebu City in 1992 amounted to an estimated 55,828 metric tons, or approximately 143,000 barrels of oil equivalent (boe). Most of this consumption took place in households with monthly incomes of less than 10,000 Philippine Pesos (P), or US$400, with use of fuelwood as a primary cooking fuel particularly common among households in the lowest income category (Table 3.1). Although rarely preferred as the cooking fuel of choice in higher income households, fuelwood is still utilized on a supplemental or backup basis by nearly one-fourth of households with monthly incomes in excess of P10,000 (Table 3.2). These households generally use fuelwood while refilling empty LPG canisters, or for cooking large amounts of food during special occasions.

Approximately 64% of the fuelwood consumed in the residential sector is purchased by households from urban-based wholesalers, retailers and itinerant vendors (Figure 3.4). Fuelwood is generally sold to households at a per unit price of around P1.50/kg (¢6), compared with bulk fuelwood logs and branches typically sold to bakeries and other commercial users for around P.70-.80/kg. On the average, fuelwood-using households purchase wood close to six times a week, although frequency of purchase ranged from once or twice a month (10.8%) up to two and even three times a day (12.7%). Generally, frequency of purchase was higher for low-income households located in densely populated squatter settlements, where traders and retailers often make fuelwood available in bundles as small as .6 kg, presumably enough wood to cook a small pot of rice. Families in these areas lack the space to store wood, and the nature of their household budget (highly constrained cash flows) limits their ability to purchase fuelwood in larger quantities even if this does tend to reduce per unit costs. Nearly all of the households (95.6%) purchasing fuelwood are able to obtain regular supplies of this fuel within 1 km of their residence.

An additional 17.5% of residential sector fuelwood supplies are delivered directly to households, either by rural traders or by fuelwood-cutters who haul bundles of wood to residential neighborhoods in the foothills of the city and sell these door-to-door (Figure 3.4). Households receiving fuelwood directly from rural traders are generally operating some form of business on the premises, such as an eatery, which requires fairly substantial quantities of this fuel. Finally, 18.4% of household fuelwood requirements are met through wood that is freely-gathered or collected from the urban environment (Figure 3.4). Some families obtain this wood from construction or demolition activities occurring on or near their premises, others from household members working in lumber yards, construction sites, or as a carpenter or woodcrafter. Still other families collect this wood from vacant lots, garbage dumps, parks, and along riverbanks and the seacoast, with the responsibility for collection generally shared about equally between male and female members of the household. Slightly over half of all fuelwood-using households were found to be collecting at least some of their wood for free, with over 20% of these households using freely-collected wood for all of their fuelwood requirements.

A distinction was made between fuelwood used in the residential sector for household cooking requirements only, and that used in this sector for commercial activities taking place on the household premises. Around 22.5% of residential sector fuelwood use is actually intended for household-based commercial purposes (Figure 3.4), with nearly all of this accounted for by food-related businesses. An additional distinction was made between different "types" of fuelwood being consumed by households. Figure 3.5 illustrates that around 63% of the fuelwood being consumed in the residential sector of Cebu City is actually in the form of *primary* woody biomass taken from trees and shrubs grown in the province. Scrap wood meets 19% of residential fuelwood demand (Figure 3.5). Most of the scrap wood used in households is collected freely from construction sites or lumber yards, but there is also a growing commercial trade in scrap wood, with some urban traders specializing in selling this kind of fuel. Another 16% of household fuelwood demand is actually in the form of non-woody coconut fronds (Figure 3.5), most of which originates from rural coconut-producing regions of the province. Coconut fronds are sold in urban markets at a per unit price approximately 20-30% lower than *primary* fuelwood. Finally, around 2% of residential fuelwood demand is met through the use of bamboo

(Figure 3.5), about half of which is purchased from traders and the rest gathered from along riverbanks and the seacoast.

In deriving an estimate of average per capita and household levels of fuelwood consumption, care had to be taken to account for those households that only use wood on a secondary basis, as well as for households where a significant amount of fuelwood is consumed for commercial sector activities taking place on the premises. For the city as a whole, including both fuelwood-using and non-using households, the average per capita and household consumption levels were 93 kg/annum and 541 kg/annum, respectively. Looking only at fuelwood-using households, regardless of whether fuelwood is the *primary* cooking fuel or used only on a secondary basis, per capita and household consumption levels increase to 204 kg/annum and 1,183 kg/annum, respectively. Finally, taking only those households where fuelwood is the primary cooking fuel, per capita consumption increases further to 303 kg/annum, and household consumption to 1,757 kg/annum. Depending on how we categorize sectoral woodfuel consumption, however, estimates of per capita and household fuelwood usage can be revised still further to reflect usage of this fuel in household-based commercial activities. Subtracting out fuelwood usage for commercial purposes, estimates of per capita and household fuelwood consumption for families using wood as their primary cooking fuel decline to 235 kg/annum and 1,362 kg/annum, respectively.

Estimates of per capita fuelwood requirements in Cebu City are generally on the lower end of per capita consumption figures reported in other developing country energy studies. For instance, annual per capita fuelwood consumption for households using wood as their primary cooking fuel have been estimated at 291 kg in Bangladesh (Prior 1986), 350 kg in Hyderabad, India (Alam *et al.* 1985a, b), 336 kg in urban areas of Java, Indonesia (Fitzgerald *et al.* 1990), 360 kg in Kano, Nigeria (Cline-Cole *et al.* 1990b), 730 kg in Ilocos Norte, Philippines (Hyman 1985), and 496 kg in Sri Lanka (Wijesinghe 1984). The relatively lower levels of per capita fuelwood consumption encountered in Cebu could be the result of a number of factors. First, as discussed above, multiple fuel usage is common in many Cebu City households, tending to depress levels of consumption for the primary cooking fuel. Second, the frequency of meal purchases from prepared food vendors is quite high among low-income households in the city (averaging around 30 meals a month), tending to reduce the cooking energy requirements of these families, most of whom rely on fuelwood.

Per capita fuelwood consumption was compared with household size in order to determine if larger families were achieving economies of scale in their fuelwood consumption. Figure 3.6 illustrates that as household size increases, per capita fuelwood consumption does, in fact, decline. Average per capita fuelwood consumption drops from around 40 kg/month in households with one or two members, to only around 12 kg/month for households with nine or more members (Figure 3.6). This tendency towards scale economies in fuelwood consumption has been observed in other developing country urban settings (Foley 1985; Fitzgerald *et al.* 1990; Cline-Cole *et al.* 1990a; Ouerghi 1993), and is an important consideration in projecting future levels of woodfuel demand since it implies that demographic changes that alter household structure also need to be considered. To the extent that average household size increases — a trend which is noticeable among low-income migrant families living in extended family arrangements — per capita fuelwood consumption can be expected to decline. On the other hand, urban lifestyle changes eventually favor smaller nuclear families which, assuming they continue to use fuelwood, would tend to result in increased per capita consumption.

In contrast with reports in the literature of low-income urban households having to spend from 20 to 40% of their monthly income on fuelwood purchases (Baidya 1984; Manibog 1984; Elkan 1988), our research indicates that even the lowest income households in Cebu were only required to spend around 5% of monthly household income on fuelwood (Figure 3.7). This could be due in part to the fairly widespread practice of using scrap wood and other fuelwood freely gathered from the urban milieu. Among households in the lowest income range, 44% of all fuelwood use is freely gathered. A failure to account for such a significant amount of fuelwood gathering from the urban environment results in overestimates of the financial burden of fuelwood purchases. However, it could also be argued that time spent collecting wood should be valued, and that the social costs of some collection activities, such as children searching for wood in garbage dumps, exceed even the market price for this fuel.

Overall, fuelwood-using households gave a variety of reasons besides income for their decision to utilize this fuel. It's interesting to note that a preference for the taste of food cooked with wood was the most common (65.2%), and the single most important determinant for nearly one-third (30.4%) of the fuelwood-using households. Next in importance is a perception of fuelwood as an inexpensive fuel, although by this many respondents were referring to the overall economics of using this fuel — including stove costs and ability to purchase in small quantities. Convenience and ease of purchase were important factors for 33.9% of the fuelwood-using households, with most families reportedly able to purchase fuelwood within a few hundred meters from their residence in quantities and at prices commensurate with their budget and restricted cash flows. Close to one-third of the households using fuelwood cited an access to free sources (such as scrap and construction wastes) as one reason for using wood, with this being the single most important determinant for 13.4% of them. Other common reasons cited were that fuelwood fires are hotter, that fuelwood is a better fuel for certain types of cooking (e.g. stews), and that fuelwood stoves are inexpensive or can be made for free. These findings suggest that non-cost factors such as taste and easy availability are often important determinants in household decisions to use woodfuels, and that considerations of fuel costs include not just fuel prices but also equipment costs and the ability to purchase in small quantities on a daily basis.

Charcoal. Charcoal is used as the *primary* cooking fuel in 5.6% of Cebu City's households (Table 3.1), and at least some of the time by 71.8% of the total (Table 3.2). Aggregate charcoal consumption in the residential sector of Cebu City in 1992 is estimated at 7,966 metric tons (around 500,000 sacks), or approximately 38,237 boe. While low income households are more likely to utilize charcoal as a primary cooking fuel, the proportion of households in each income category utilizing this fuel on at least a supplemental basis actually increases with income (Table 3.2). This pattern points to the popularity of charcoal as a supplemental cooking fuel in higher income households, where it is regularly used for cooking fuel-specific dishes (such as barbecue) as well as for slow and steady cooking of stews, beans or soups. Only 25.9% (2,066 tons) of charcoal consumption in the residential sector actually occurs in households where this is the primary cooking fuel, the remainder is used in households where charcoal is a secondary cooking fuel or used exclusively for ironing. Overall, 13.8% (1,099 tons) of the charcoal consumed in the residential sector is intended for household-based commercial activities, especially for the operation of small-scale barbecue stands. In addition, it's estimated that nearly one-third (2,481 tons) of the charcoal consumption in Cebu's households is used for ironing of clothes.

The majority of households using charcoal purchase this fuel in small cellophane bags weighing from .2 to 1 kg each, at an average per unit price of around P5/kg (¢20). These bags are available from *sari-sari* or small, general stores in most neighborhoods, as well as from itinerant charcoal vendors. As with fuelwood, nearly all (94.4%) households using charcoal reported being able to purchase this fuel within 1 km from their residence. Households that make greater use of charcoal for family cooking or for commercial purposes, as well as a number of higher-income households, usually purchase charcoal by the sack, either from urban traders or from rural traders who deliver this fuel directly to them. Sacks of charcoal generally weigh around 15-16 kg each, and cost approximately P60, resulting in an average per unit price of around P4/kg (¢16). The lower per unit price of charcoal purchased in sacks compared to that in bags is, however, partially offset by the fact that anywhere from 5-15% of the weight of a charcoal sack was found to consist of essentially unusable fines and other non-combustible material.

Per capita and household charcoal consumption levels in Cebu City, regardless of whether a household uses this fuel or not, are 13 kg/annum and 78 kg/annum, respectively. Looking only at charcoal-using households, but not considering whether this is a primary or supplemental fuel, yields a per capita consumption level of 19 kg/annum and a household consumption level of 109 kg/annum. Finally, considering only those households where charcoal is the primary cooking fuel, per capita and household consumption levels increase to 65 kg/annum and 380 kg/annum, respectively.

Estimates of per capita charcoal requirements in charcoal-using households in Cebu also appear to be relatively low compared with figures reported for other parts of the developing world. Bess (1989) reports per capita annual consumption levels of 72-100 kg for Nairobi, Kenya, while Soussan (1990) estimates per capita charcoal requirements in Mogadishu, Somalia at 156 kg/year. Foley (1985) reports an annual per capita charcoal consumption range of from 100 to 160 kg for a number of developing country urban areas. Once again, it appears that multiple fuel usage and prepared food purchases could be lowering per capita charcoal requirements. Per capita charcoal use is also affected by household size, as illustrated in Figure 3.8. Average per capita monthly charcoal consumption declines from around 10 kg in households with 1-3 members to less than 5 kg in households with more than six members.

For households using charcoal as their primary cooking fuel, an average of 4.9% of their monthly household income was spent on purchases of this fuel. Charcoal purchases as a percent of monthly income did, however, average 8% for the lowest income group as a whole, and as much as 16% for a few households within this group (Figure 3.9). Comparing average per capita annual charcoal requirements for households using this as their primary cooking fuel (65 kg), with that for fuelwood (235 kg), and assuming average per unit prices of P5/kg for charcoal and P1.5/kg for fuelwood, it appears that charcoal is slightly less expensive. However, many fuelwood-using households are able to obtain at least some of their fuel requirements through freely gathered supplies, which is not an option with charcoal. Rather than cost, it appears that charcoal is preferred over fuelwood by some households mainly for reasons of convenience (charcoal is less bulky), cleanliness (it's less smoky), and taste. It's possible given the rapid rate of urbanization occurring in the Metro Cebu area, and increasingly dense settlement patterns, that charcoal will enjoy more widespread use as a household cooking fuel in the future, and perhaps serve as a transition fuel for a more long term fuel-switching trend from fuelwood to LPG.

Kerosene. Kerosene is the *primary* cooking fuel for 19.9% of Cebu City's households (Table 3.1), and is used on at least a supplemental basis as a cooking fuel by a total of 30.3% of the city's households (Table 3.2). In addition to its use as a cooking fuel, kerosene is also used in small quantities by 62.5% of the city's households for lamps used during electric power outages, as well as a "fire-starter" in fuelwood and charcoal-using households. Residential sector kerosene consumption in Cebu City in 1992 is estimated at nearly 6.6 million liters, or 39,456 boe. Kerosene is most widely used in the lower-middle and middle income categories (monthly income of P2,000-9,999), a pattern that has earned kerosene the reputation of a transition fuel between woodfuels and LPG (Barnes and Qian 1992).

Kerosene is readily available in various units throughout the city, with kerosene-using households citing easy availability as one of the primary reasons for utilizing this fuel. Kerosene is least expensive when purchased by the liter from formal sector service stations (the average official price in 1992 was around P7.50/liter), but the greatest number of households purchase this fuel from neighborhood *sari-sari* stores. These stores also sell kerosene by the liter (typically for around P8-10/liter), but this fuel can also be purchased in quantities as small as 50 ml. Kerosene purchase patterns are similar to those observed for fuelwood and charcoal, with relatively low income households tending to purchase smaller quantities on a more frequent basis (often 1-2 times a day) but at a higher per unit cost. In contrast, kerosene-using households in the middle and upper-middle income categories tended to purchase in larger quantities from formal sector service stations at per unit costs some 15-20% lower than that sold in *sari-sari* stores. Overall, 83.8% of kerosene-using households were able to purchase this fuel within 1 km from their residence.

For those households using kerosene as their primary cooking fuel, household and per capita annual kerosene consumption was 197 liters and 37 liters, respectively (or 16.4 and 3.1 liters a month). This compares with an annual average consumption range of 240-324 liters for households in urban areas of Java, Indonesia (World Bank 1990). The lower kerosene consumption levels in households in Cebu City are also likely the result of multiple fuel use practices and prepared food purchases, especially the former. Many households were found to be using a fuelwood/kerosene or charcoal/kerosene combination on a fairly regular basis. Table 3.1 shows that 2.2% of the households in Cebu were using a woodfuel/kerosene combination simultaneously, and on a near equal basis, justifying a separate category for such a combination. In addition, among the households listed using kerosene as their primary cooking fuel, nearly one-fourth also use fuelwood on a supplemental basis (on average around seven times a month), and 10% use charcoal as a secondary fuel (on average three to four times a month). A common practice is to use fuelwood or charcoal for cooking one large pot of rice to last for three meals, while a kerosene stove is utilized in preparing or heating up vegetable, fish or meat side dishes two or three times a day. Households using kerosene as their primary cooking fuel also had a higher reported frequency of food purchases from prepared food vendors (29 times a month) than the overall city average, tending to reduce per capita requirements.

Figure 3.10 plots per capita kerosene consumption levels relative to household size. Scale economies in the use of kerosene are not as apparent as those observed for fuelwood and charcoal (Figures 3.6 and 3.8). Figure 3.11 plots expenditures on kerosene as a percentage of monthly household income for households using this as their primary cooking fuel. With the exception of households in the lowest income category, some of whom spent 15-20% of their income on kerosene, most households using this fuel spent less than 5% of monthly household income on kerosene purchases. The higher share of monthly income going to kerosene purchases in the low income category is probably a function of lower overall incomes *as well as* higher per unit prices paid by these families since they tend to purchase in smaller quantities from neighborhood stores.

Households using kerosene as a cooking fuel do so largely because they find this fuel to be relatively more convenient than fuelwood, and relatively more affordable than LPG. Locally-made kerosene stoves of reasonable quality can be purchased new for P200-300 ($8-12), re-built stoves sell for as low as P100. In addition, the use of kerosene as a cooking fuel does not generate smoke, an important consideration in densely populated low-income settlements. That many low- and middle-income households continue to use fuelwood instead of kerosene is largely a result of a strong taste preference against foods cooked with kerosene, as well as widespread concern over kerosene stove safety.

Liquefied Petroleum Gas. LPG is the *primary* cooking fuel for 38% of Cebu City's households (Table 3.1), and is used on at least a supplemental basis by a total of 41.6% of the city's households (Table 3.2). The small difference between these two figures (compared with those for fuelwood, charcoal and kerosene) suggests that once a household obtains the equipment necessary to use LPG, they are likely to rely on this fuel for the largest portion of their household cooking energy requirements. Residential sector LPG use in Cebu City in 1992 is estimated at 5,787 tons, or 45,080 boe. LPG is most widely used in the middle, upper-middle, and upper income categories (monthly income greater than P5,000), although close to one-fourth of lower-middle income households are able to use this fuel on a primary basis (Table 3.1).

In order to use LPG, households must either purchase or place a deposit on an LPG cylinder, the most common size holding 11 kg of this fuel (50 kg cylinders are also marketed, mainly for commercial establishments and upper-income households). The three major oil companies operating in the Philippines (Shell, Caltex and government-owned Petron) each market LPG under their own brand names and in non-transferable cylinders. In addition, there are a limited number of local bottlers who buy in bulk from the oil companies and then market their own brands. Approximately three-fourths (75.6%) of LPG-using households bring their empty cylinders to service stations to be refilled, with the reminder having replacement bottles delivered. Although LPG delivery services are available in most parts of the city, the majority of households still go to the trouble of bringing bottles (which weigh 14 kg when empty, 25 kg when full) in to be refilled. There are a number of reasons for this. First, LPG delivery services have a reputation for under-filling bottles. Second, after running out of fuel a household might have to wait 1-2 days before having a replacement delivered, and many households cannot afford the luxury of keeping two tanks to be used on a rotating basis. Refilling of LPG canisters is perhaps the only major inconvenience associated with using this fuel, especially since the largest percentage of LPG-using households have to travel over 2 km to have this done. The fact that most of the upper-middle and upper income households in Cebu rely on household help to do this for them tends to make this inconvenience less of a concern.

For those households using LPG as their primary cooking fuel, household and per capita annual consumption of this fuel was 138 kg and 24 kg, respectively (or 11.5 kg and 2 kg a month). This compares with average annual consumption of LPG of 216 kg in urban households in Java, Indonesia (World Bank 1990). Once again, the relatively lower consumption requirements for LPG in Cebu could be due to the practice of multiple fuel use, with charcoal and electricity the most widely used supplemental fuels. Among households using LPG as their primary cooking fuel, nearly 30% also make use of charcoal for supplemental cooking purposes, cooking with charcoal on an average of 3-4 times a month. A fairly common practice, even among high income households, is to cook rice with charcoal, primarily for taste reasons, while using LPG for the balance of the cooking. Since most of the cooking in higher income households is done by hired servants, the relative inconvenience associated with using charcoal is less of a problem. In addition, 10% of LPG-using households were found to be supplementing this fuel by using an electric stove or burner, a practice made easier by the fact that many of the LPG stove/oven combinations in the higher price range actually have an electric burner built into them as the fourth unit on top. Finally, 16.5% of LPG-using households also make use of an electric rice cooker, on average over ten times a month, a pattern which tends to lower overall household LPG requirements.

Figure 3.12 plots monthly per capita LPG consumption relative to household size. Figure 3.13 plots expenditures on LPG as a percentage of monthly income for households using this as their primary cooking fuel. With the exception of a limited number of low income households, most families using LPG as their primary cooking fuel spend only around 2-4% of their income on purchases of this fuel.

LPG is clearly the most preferred household cooking fuel in urban Cebu, with 55% of all respondents (regardless of actual current fuel choices) preferring it to other alternatives. Purchasing LPG is somewhat more difficult than it is for woodfuels or kerosene, although the frequency of purchase is far less. LPG is more convenient and clean to use than other available cooking fuels, and it does not generally impart a bad aroma or "oily" taste to food as is commonly said to happen with kerosene. However, LPG stove costs and the "lumpy" nature of payments for this fuel continue to preclude many lower income households from using it. Depending on the model and size, a new LPG stove can cost anywhere from P800-10,000. Purchase of an LPG cylinder requires another P1,000 or a hefty deposit. Even if low income households could afford such a purchase, the need to buy LPG 11 kg at a time, requiring a lump-sum payment of P130-140, discourages many from using this fuel. Rising incomes, new one-burner mini LPG stove designs, and test marketing of 6 kg LPG canisters, could serve to help overcome some of these obstacles in the future.

Impacts of Prepared Food Purchases on Residential Energy Demand. Our survey found that many households were relying on prepared food vendors and eateries for a substantial portion of their meals. Since prepared food vendors generally cook larger quantities of food they could be achieving scale economies in energy use, thereby reducing overall per capita energy requirements for meal preparation.

The proliferation of an informal sector street food trade is not unique to Cebu or the Philippines. Instead, it appears to be a fairly widespread phenomenon common to many urbanized areas of the developing world (Tinker and Cohen 1985; Astilla *et al.* 1988; Leach and Mearns 1988; Sathaye and Tyler 1991). The largest concentration of prepared food vendors are located in low-income districts of the city and in areas where there are large numbers of factories, schools, or government offices. The proliferation of prepared food vendors in low-income districts of cities like Cebu is often an outcome of changes in work and settlement patterns brought on by increased urbanization. With household members being drawn into the workforce — regardless of whether this involves formal or informal sector employment — less time is available for other activities, including daily marketing for fresh foods (since many households lack refrigeration) and meal preparation.

It's interesting to note that the frequency of household prepared food purchases increases just as income declines (Figure 3.14). In the lowest income category, over 40% of respondent households were purchasing from prepared food vendors *at least* once a day, while close to one-fourth patronize these vendors two or more times daily. In contrast, only around 10% of the households in the two highest income categories reported daily purchases of prepared foods which, more often than not, came from formal sector eating establishments.

There is also a tendency for prepared food purchases to be higher in densely-populated areas of the city, even after controlling for income. Table 3.3 illustrates that in sparsely-populated peri-urban districts, households typically purchase from prepared food vendors 14.2 times per month on average, with lower-income households showing a greater tendency towards prepared meal purchases. In thirteen inner-city districts looked at, average monthly meal purchases increase to over 30 per month, with the lowest income households in these areas averaging 37 purchases per month. These differences result from a combination of factors. First, low-income households in densely-populated districts tend to be more involved in the urban low wage-earning economy. Individuals in this group work long hours, leaving less time for meal preparation activities. Second, the close spacing of housing units in densely-populated regions of the city can preclude regular use of fuelwood due to problems with smoke. At the same time, low income families in these areas are often unable to purchase kerosene or LPG stoves, forcing them to resort to purchasing most of their food from vendors.

It is uncertain what impact increased prepared food purchases will have on future demand for cooking fuel in general, and for fuelwood in particular. It is conceivable that increased purchases of prepared foods from vendors could lead to reductions in overall levels of woodfuel demand since food vendors achieve scale economies in energy consumption. Research done in Kenya suggests that a trend towards increased purchases of pre-cooked foods from fuel-efficient large consuming units is partly responsible for 30% reductions in per capita levels of urban charcoal use in recent years (Bess 1989; Cline-Cole *et al.* 1990a). In Cebu, two offsetting factors are at work. First, prepared food vendors sell mainly to low-income households who usually use fuelwood. On the other hand, the prepared food vendors themselves are highly reliant on fuelwood, with around 70% of them using this fuel on a primary or supplemental basis.

At the very least we can conclude that the proliferation of prepared food vendors is altering the relative shares of woodfuel used in the residential and commercial sectors. With regards to a decline in overall levels of woodfuel consumption due to scale economies, we know from Figures 3.6 and 3.8 that per capita woodfuel consumption decreases as the size of the household — and presumably the amount of food being cooked — increases. However, prepared food vendors operate at many differing scales, making any precise determination of woodfuel savings difficult based on the data available to us.

Fuel-Switching in the Residential Sector

The notion of a household fuel-switching transition in urban areas of the developing world is widely reported in the literature, with the most common trend being that of urban households replacing woodfuels with kerosene, LPG or electricity for their cooking fuel requirements (Sathaye and Meyers 1985; Leach 1988; Fitzgerald *et al.* 1990; Soussan *et al.* 1990; Sathaye and Tyler 1991). In some cities this trend has been very rapid and one-directional, in others, including Cebu, the fuel-switching trend appears to be moving in fits and starts and sometimes even reversing itself over time. A number of factors are posited to be behind fuel-switching trends, namely, increasing incomes, improved availability and access to modern fuels, and basic changes in urban lifestyles and settlement patterns which make cleaner, more compact fuels such as kerosene and LPG more attractive to household users. Generally speaking, the extent to which modern fuels replace woodfuels in a particular urban area is determined by city size and level of economic development. Therefore, we find that cities like Bangkok and Kuala Lumpur have only a small percentage of households still reliant on woodfuels (Sathaye and Meyers 1985; Sathaye and Tyler 1991), while smaller cities like Cebu, or cities in relatively low-income countries such as Port-au-Prince, Haiti or Kano, Nigeria are still heavily reliant on woodfuels for meeting household cooking energy requirements (Stevenson 1989; Cline-Cole *et al.* 1990b; Hosier and Bernstein 1992).

An important point to stress in discussing fuel-switching trends is to acknowledge that switching behavior is rarely discrete, and that reverse fuel switching can, and in fact, has occurred in a number of places (Leach and Mearns 1988; Munslow *et al.* 1988; Leitman 1991). The first point leaves open the possibility that even after a household has switched to LPG or kerosene, they may still make extensive use of fuelwood or charcoal as a back-up fuel or for specific cooking practices, a pattern noted above for Cebu. The second point is relevant given the degree of dependency of countries like the Philippines on *imported* petroleum, and the strain this places on scarce foreign exchange. It's not inconceivable that much of the increased usage of kerosene and LPG in Philippine households over the last 30 years could be erased in the event of a new world oil crisis and price increase of the magnitude experienced in the early and late-1970s.

Figures 3.15a and b illustrate the changes in primary cooking fuel usage by the residential sector in Cebu City for the census years 1960, 1970, 1980 and 1990, as determined by the decadal Census of Population and Housing. A clearly discernible trend away from fuelwood and towards more widespread use of LPG and kerosene can be noted (Figure 3.15a). The most rapid change, on a percentage basis, occurred between 1960 and 1970, at a time of low and steady petroleum prices and substantial improvements in the handling, storage and delivery facilities of oil companies operating in the Philippines (Paderanga and Paderanga 1988). The trend stalled somewhat between 1970 and 1980 due in large part to sharp price increases and curtailed supplies of petroleum products in 1973-74 and again in 1980, the year of the census. The period from 1980 to 1990 witnessed another significant drop in the percentage of households using fuelwood as their primary cooking fuel, with increased kerosene usage accounting for much of this change (Figure 3.15a). It should be noted, however, that the 1990 census was conducted in May of that year, two months prior to the outbreak of conflict in the Persian Gulf and subsequent price increases and rationing of petroleum products in the Philippines.

In estimating future residential sector consumption of woodfuels in urban Cebu, and designing agroforestry and land use management strategies to meet that demand, care should be taken to distinguish between the *relative* contribution of woodfuel and the *absolute* contribution. While Figure 3.15a shows a dramatic trend away from woodfuels on a percentage basis between 1960 (91.8%) and 1990 (36.9%), Figure 3.15b reveals that the *number* of households using fuelwood as their main cooking fuel actually increased by close to 5,000 during the same period due to a near tripling of the residential sector population in the city. Usage of charcoal as a primary cooking fuel also increased by over 5,000 households during this period. In addition, it appears that relative prices for woodfuels, kerosene and LPG may change in the near future with the impending deregulation of the petroleum industry in the Philippines and planned phase-out of cross price subsidies for the latter two fuels. Elimination of subsidies on fuels like kerosene and LPG could lead to as much as a 30-40% increase in their price, while increasing diesel prices could translate into slightly higher woodfuel prices since much of the commercially-traded woodfuel is transported in diesel conveyances. While a 30-40% price increase for LPG and kerosene fuels would be unlikely to induce significant reverse fuel-switching, it could have the effect of slowing down current trends and encourage increased use of woodfuels on a supplemental basis. This combined with continued increases in population is likely to result in a situation where the absolute demand for woodfuels will remain steady if not actually increase.

While the census data clearly show the extent to which households in

Cebu City have changed their primary cooking fuel between 1960 and 1990, it provides no information on the reasons for, or the context within which, these fuel-choice decisions took place. Our survey asked respondent households to provide information on any fuel-switching they may have undergone in the five years prior to the interview. In all, 18.7% of the households reported at least one fuel-switch during that period, and a number of households experienced two and even three switches over a five year span. Table 3.4 illustrates the types of fuel-switching taking place and the relative importance of each between income categories, while Figure 3.16 shows the end result of these switches in terms of primary cooking fuel choice. The two most common switches were from fuelwood to kerosene (34.5% of the total) and kerosene to LPG (15% of the total), a result which tends to support the notion that fuel-switching in most developing country urban areas proceeds from traditional to modern fuels, and that kerosene is usually a transition fuel between traditional woodfuels and the more preferred modern fuels, LPG and electricity. Of those households switching out of fuelwood, the three most important reasons given for this decision relate to the inconvenience involved in using fuelwood (too smoky, too time consuming, needs to be watched closely), the higher cost of fuelwood relative to kerosene or LPG, and the lack of space needed to store fuelwood supplies.

Households switching out of kerosene moved in two different directions and for two very different sets of reasons. Around half of the households switching out of kerosene changed to LPG, usually as a result of improvements in the household financial situation or the receipt of an LPG stove as a gift, often from a family member working abroad as an overseas contract worker. Another 54% of the households switching out of kerosene moved to fuelwood or charcoal, almost always because their kerosene stove broke and they could not afford to repair it, or their stove was defective and they were fearful of fire. It appears that once a household is able to start using LPG they are far less likely to switch back out of it again compared with the case for kerosene. There were, however, a number of switches out of LPG back into kerosene, fuelwood and charcoal. These switches resulted either from a perception of kerosene as a less expensive fuel, problems with an LPG stove, or fear of continued use of LPG due to news reports of cylinder explosions and fires associated with the use of this fuel.

Once all fuel switches are accounted for, we find that out of our sample there were 33 fewer households using fuelwood as their primary cooking fuel compared with five years earlier, 20 more using LPG, 13 more using kerosene, and the same number using charcoal. While this result supports the overall trend away from fuelwood and towards LPG (with charcoal and kerosene acting as transition fuels), the discussion above also illustrates that household fuel-switching behavior in a rapidly-urbanizing setting like Cebu is an extremely dynamic and non-discrete process.

Electricity

Approximately 93% of households in Cebu City are electrified. The most common reason for not having electricity is that the installation charge is too expensive. In addition, a number of households were unable to obtain electricity because the local utility (the Visayan Electric Company or VECO) would not make a connection on account of the dwelling being made of unsafe, fire hazardous material (such as thatched roofing).

Residential sector use of electricity for cooking is *not* common in urban Cebu. Overall, only 1% of households use electricity as their primary cooking fuel (Table 3.1), although 10% make use of electric cooking devices on an occasional basis. Rice cookers are the most commonly used electric cooking device, owned by 13.4% of households but only actually used by 9.9% of them. On average, households owning rice cookers will use this device 1-2 times a day. Electric cooking stoves or burners are the second most widely-used electric cooking device, owned by 7% of households but only used by 4.3% of the total. The relative convenience of cooking with electricity in a place like Cebu is offset by the frequent interruptions in supply and the relatively high residential sector power rates in the Philippines (VECO, for instance, charges its residential consumers an average of ¢11.8/kWh).

Electricity is used for lighting in 100% of electrified households. Figure 3.17 shows the average number of incandescent and fluorescent lights in use in Cebu City households by income category. It's interesting to note that even in the lowest income households slightly more than half the bulbs in use are fluorescent, despite the relatively higher first-time costs for fluorescent bulbs and fixtures. As household income rises the number of lighting units in use increases, as does the percentage of fluorescent lights in the total. Although we did not distinguish between regular and compact fluorescent lighting units, it appears that the latter, relatively more energy-efficient variety is enjoying increased usage in higher income Philippine households (UNDP/ESMAP 1992).

Table 3.5 presents appliance saturation rates for 17 commonly-owned electric appliances in use in Cebu City households, by income category. With the exception of black-and-white televisions, the percentage of households owning at least one of these devices increases with income. The most widely-owned appliances are electric fans (69.3%), radios (61.1%), electric irons (52%), refrigerators (48.5%), color and black-and-white televisions (47.2 and 42.4%, respectively). Based on frequency of ownership and electricity requirements, refrigerators are probably the largest consumer of residential sector electricity.

The largest increases in appliance saturation rates — and perhaps the most important from an energy planning perspective — occur between households in the middle income and upper-middle income categories. Figure 3.18 illustrates this better for some of the most widely-used appliances. As monthly household income approaches and exceeds P10,000, ownership and use of more electricity-intensive devices like refrigerators, color televisions, video players, washing machines and air conditioners increase dramatically. For washing machines and air conditioners, there is another sharp increase in ownership between the upper-middle and high income households (Figure 3.18). Even relatively modest improvements in the Philippine economy, and in levels of household income, can be expected to result in increased appliance saturation rates for the bulk of the population, thereby tending to maintain growth in residential sector electricity demand.

Figure 3.19 plots expenditures on electricity as a percentage of household income for all electricity-using households. Unlike the pattern observed for the major cooking fuels in use in Cebu City households (Figures 3.7, 3.9, 3.11 and 3.13) — where the percentage of income spent on these fuels dropped sharply as incomes rose — expenditures for electricity as a percentage of income drop less noticeably across the income spectrum, even increasing slightly on average between the middle and upper-middle income categories. Whereas overall cooking energy requirements remain relatively constant in households of the same size regardless of income, electricity clearly behaves more like a normal good, increasing in use as incomes rise.

Likewise, the relation between number of household members and per capita electricity consumption was not as apparent as it was for the cooking fuels discussed above. Figure 3.20 plots per capita electricity requirements for households of different size, showing that as the number of household members increases from 1-2 to 5-6, average per capita electricity use drops by about half. Beyond that point, however, average per capita use remains relatively constant, perhaps reflecting the tendency for larger households to have more income earners and thus more electric devices and appliances.

A recently-completed household energy consumption study carried out in the Philippines by the World Bank and the Philippine Office of Energy Affairs suggests that the residential sector should be the primary target of future electricity conservation/efficiency campaigns in the country (UNDP/ESMAP 1992). Although penetration of fluorescent bulbs in the residential sector lighting mix in the Philippines (and in Cebu) is relatively high by developing country standards (Figure 3.17), there is still scope for increased use of regular fluorescents, as well as more energy-efficient compact fluorescents, in households. Likewise, improved efficiency of major household appliances, especially refrigerators, holds potential for reducing the rate of growth in residential electricity demand. The Philippine government is also taking measures to encourage more efficient appliance designs, such as through testing and labelling of energy requirements. Overall, residential sector electricity use in Cebu City appears far from saturation, and any future improvements in living standards for lower and lower-middle income households will entail more widespread ownership of electricity-intensive devices. Power sector planning should account for this, and where economically justified demand-side management programs should be pursued to help avert future power shortfalls.

Discussion and Conclusion

In 1992, the residential sector in the 49 urban *barangays* of Cebu City (a total of 102,446 households) consumed an estimated 55,828 metric tons of fuelwood, 7,966 tons of charcoal, 6.6 million liters of kerosene, 5,787 tons of LPG and 127,200 megawatt-hours (MWh) of electricity. Figure 3.21 converts this consumption into normalized units (gigajoules), showing that on an input basis fuelwood is the most important source of energy in the residential sector, accounting for 41.6% of overall energy consumption and 52.9% of cooking fuel requirements. However, since end-use efficiencies of fuelwood stoves are generally lower than those for charcoal, kerosene or LPG, the actual contribution of fuelwood to meeting *delivered* energy requirements of households is less. Figure 3.22 converts the consumption figures for each of the four major cooking fuels using assumed energy conversion efficiencies of 15% for fuelwood, 20% for charcoal, 40% for kerosene and 55% for LPG (following UNDP/ESMAP 1992). Once this is done, LPG makes the largest contribution to the household cooking energy budget, meeting 36.8% of the total (Figure 3.22).

Because of differences in energy conversion efficiencies, low income households using primarily biomass fuels tend to have fairly high levels of energy consumption on an input basis. Figure 3.23a plots average monthly household consumption of the four major cooking fuels and electricity.[2] From Figure 3.23a it appears that households in the lowest three income categories have nearly identical levels of energy use, and that energy consumption *exclusive* of electricity actually declines as incomes increase. When average consumption levels are adjusted to reflect assumed end-use efficiencies the situation changes (see Figure 3.23b). Now, overall energy use more than doubles between the first and third income categories, and cooking energy use increases steadily across the income spectrum. Although cooking energy use might be expected to level off or saturate at higher income levels, the approximate doubling of average cooking energy use between the lowest

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[2] Although electricity *is* used on a moderate basis for cooking, the amount of electricity actually used for this purpose could not be separated out from the total and so the consumption figures presented represent overall electricity use. Likewise, nearly one-third of charcoal consumption actually goes towards ironing clothes, and a small percentage of kerosene usage is for lighting.

and highest income category suggests otherwise. This tendency could be caused by a number of factors. First, as discussed above, lower income households tend to cook less and rely more on purchases of prepared foods from vendors, thereby reducing their cooking energy requirements. Second, higher income households also tend to have more members, with average household size increasing from 4.7 members in the lowest income category to 5.4, 5.8, 6.8, and 7.6 in the next four income categories, respectively. As a result, and even though scale economies in cooking energy use are present, higher income households are likely to use more cooking energy.

In addition, lower income households could be more conservation-conscious in their use of energy if for no other reason than to save money. Figure 3.24 shows that households in the lowest income category spend around 10-15% of their monthly income on energy purchases, compared with around 4% for the highest income group. This is the case even though the higher income households consume twice as much energy on an input basis and six times as much on an end-use basis. While our survey did not explicitly ask for information regarding energy conservation practices, there were indications that some low income households did take measures to reduce energy consumption, ranging from cooking fewer meals to more careful management of wood fires.

Figures 3.23a and b illustrate that fuelwood is considered an inferior good, steadily declining in use as incomes increase. In contrast, charcoal is clearly considered a normal good, with average per capita consumption levels increasing more than four-fold across the income spectrum. This pattern reflects the popularity of charcoal among higher income households for specific cooking purposes and for food preparation on special occasions. Kerosene behaves as a normal good from the lowest to the middle income category, and then as an inferior good beyond that. LPG is clearly a normal good across all income categories. Finally, electricity shows the most rapid increase in use as incomes rise, reflecting the many uses of this form of energy besides cooking.

Based on the above discussion a number of conclusions can be made regarding residential sector energy use patterns in Cebu City, as well as the possibility for policy or project interventions to either improve the overall efficiency of energy use or mitigate some of the environmental impacts of household energy consumption.

• Despite experiencing steady declines in *relative* usage over the past few decades, fuelwood remains an important cooking fuel in Cebu's residential sector, especially among low income households. On an *absolute* basis, fuelwood consumption may actually be increasing over time (Figure 3.15b).

To the extent that urban population growth rates remain high, and a substantial portion of the city's household population remains poor, residential sector fuelwood use can be expected to stay near current levels. Energy and environmental policy-makers in Cebu and the rest of the Philippine should work on the assumption that fuelwood use *will* remain high, and then redesign current regulations and policy in order to encourage greater production of woodfuels on private lands in order to meet this demand.

• Unlike fuelwood, charcoal use in Cebu's residential sector has been increasing in both a relative and absolute sense over the past thirty years. Increasingly dense settlement patterns — and the popularity of charcoal for fuel-specific cooking activities — suggests the likelihood that urban household demand for charcoal will increase in the years ahead.

• A limited potential exists for improving the end-use efficiencies of fuelwood and charcoal stoves in urban households, and for increasing conversion efficiencies of charcoal-making in rural regions of the province. Details of this potential are provided elsewhere (Bensel and Remedio 1993), but basically there is scope for introducing relatively more fuel-efficient fuelwood and charcoal cookstoves in urban Cebu. At present, 45% of the fuelwood stoves and 21% of the charcoal stoves in use in Cebu City households are "home-made", ranging from crude three-stone arrangements to fairly elaborate designs fashioned from scrap metal and tin. A program to train and finance local artisans in the design and production of fuel-efficient and inexpensive fuelwood and charcoal cookstoves could result in energy savings, reduced household fuel expenditures, and reductions in indoor and local air pollution.

• Subsidizing kerosene and/or LPG in order to facilitate a switch out of fuelwood does *not* appear to be a feasible or recommendable policy option at this point. In fact, the Philippine government is currently in the process of *eliminating* subsidies on these fuels. Even if kerosene or LPG fuel prices were to come down, the discussion above suggests that the more important factors preventing the wider use of these fuels are stove costs, taste preferences, and issues of safety. Inexpensive single- or double-burner LPG stoves, and more widespread availability of LPG fuel in 6 kg cylinders, could help to increase the use of this fuel among some lower income consumers (although many low income households still may not switch due to the high risk of theft in many squatter settlements). Kerosene stove costs are not a major issue. Instead, negative attitudes towards the taste of some foods cooked with kerosene appear more important. Both kerosene and LPG suffer from a perception of being dangerous, a reputation more deserved of kerosene than LPG. Nevertheless, newspaper and radio reports of kerosene and LPG stove fires and explosions are a regular occurrence, and clearly serve to restrain wider adoption of these fuels. Availability of kerosene and LPG is *not* an issue in Cebu as it often is in other developing country urban areas (Barnes and Qian 1992), although purchasing LPG can be laborious and time-consuming. Overall, there appears to be little that policy-makers can or should do to "speed-up" the fuel-switching transition, except perhaps for promoting a safe stove use media campaign to warn against improper usage of kerosene and LPG stoves. Even in the absence of direct government intervention, current trends in urbanization and income growth in Cebu and other cities in the Philippines favors more widespread use of kerosene and LPG as household cooking fuels.

- Electricity use accounts for 23.7% of overall energy consumption in the residential sector of Cebu City. Although some of this electricity use is for household meal preparation, the largest percentage is accounted for by lighting and a few major appliances — notably refrigerators, color televisions, washing machines, air conditioners and electric fans. In recent years, the Philippines has experienced a nationwide power crisis which has hurt the country's economic prospects. Rapidly increasing residential sector electricity demand clearly contributed to the onset of electric power shortages. The problem of inadequate electricity supply has not been as bad in Cebu in recent years as it has been on the islands of Luzon and Mindanao. However, Cebu's industrial and manufacturing sector continues to expand, and residential sector electricity use on the island is growing faster than the national average. As a result of these trends, and the importance of Cebu to the regional economies of the Visayas and Mindanao, the Philippine government is undertaking projects to interconnect Cebu's electric power grid with geothermal power plants on the islands of Leyte and Negros. While this will improve the supply-side of the picture, demand-side efficiency improvements in residential sector electricity use in Cebu should also be looked into as a serious option for ensuring adequate availability of power.

Table 3.1: Primary cooking fuels for a sample of 603 Cebu City households, by income category, in percent and number, 1992

	Monthly Income Range[1]											
	<2000 (*n*=82)		2000-4999 (*n*=235)		5000-9999 (*n*=165)		10000-19999 (*n*=83)		≥20000 (*n*=38)		Overall (*n*=603)	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Fuelwood[2]	53	64.6	92	39.1	38	23.1	9	10.9	0	0.0	192	31.8
Charcoal	8	9.8	15	6.4	8	4.8	2	2.4	1	2.6	34	5.6
Kerosene	13	15.9	60	25.5	36	21.8	8	9.6	2	5.3	120	19.9
LPG	4	4.9	58	24.7	77	46.7	60	72.3	31	81.6	229	38.0
Electricity	1	1.2	0	0.0	0	0.0	2	2.4	3	7.9	6	1.0
Woodfuel/Kerosene[3]	2	2.4	6	2.6	3	1.8	1	1.2	1	2.6	13	2.2
Woodfuel/LPG[4]	0	0.0	1	0.4	3	1.8	1	1.2	0	0.0	5	0.8
Not Cooking	1	1.2	3	1.3	0	0.0	0	0.0	0	0.0	4	0.7

1. Incomes reported in Philippine Pesos (P), US$1=P25.
2. Includes households using sawdust, coconut husks and shells, and other types of biomass fuels except for charcoal.
3. Households which use either fuelwood or charcoal and kerosene near equally.
4. Households which use either fuelwood or charcoal and LPG near equally.

Table 3.2: Percentage of Cebu City households using each fuel for cooking on *either* a primary or secondary basis, in percent, by income category, 1992

	Monthly Income Range (P)					
	<2000 %	2000-4999 %	5000-9999 %	10000-19999 %	≥20000 %	Overall %
Fuelwood	69.5	54.0	38.2	28.9	13.2	45.9
Charcoal	53.7	72.8	74.5	78.3	76.3	71.8
Kerosene	22.0	38.7	35.2	14.5	10.5	30.3
LPG	6.1	26.4	50.9	78.3	89.5	41.6

Table 3.3: Average monthly frequency of prepared food purchases among Cebu City households, by income category and settlement pattern, 1992

	Monthly Income Range (P)					
	<2000	2000-4999	5000-9999	10000-19999	≥20000	Overall
Peri-Urban (nine districts, n=166)	15.6	17.3	15.6	6.1	7.2	14.2
Densely-Populated (thirteen districts, n=133)	37.2	33.8	31.3	19.8	6.8	30.1

Table 3.4: Frequency of fuel-switching among a sample of 603 Cebu City households between 1987-1992, by income category

	Monthly Income Range (P)					
	<2000 (*n*=82)	2000-4999 (*n*=235)	5000-9999 (*n*=165)	10000-19999 (*n*=83)	≥20000 (*n*=38)	Overall (*n*=603)
Fuelwood to Charcoal	–	–	2	–	–	2
Fuelwood to Kerosene	7	22	9	1	–	39
Fuelwood to LPG	–	7	4	–	–	11
Charcoal to Kerosene	–	2	2	–	–	4
Charcoal to LPG	–	2	1	4	–	7
Kerosene to Fuelwood	2	14	4	1	–	21
Kerosene to Charcoal	2	3	1	1	–	7
Kerosene to LPG	1	10	7	3	–	21
LPG to Fuelwood	1	–	2	2	–	5
LPG to Kerosene	–	5	1	2	1	9
Others	1	5	2	–	–	8
Total	14	70	35	14	1	134

Table 3.5: Percent of electrified households in Cebu City owning *at least one* of the following electric appliances/devices, by income category, 1992

	Monthly Income (P)					
	<2000 %	2000-4999 %	5000-9999 %	10000-19999 %	≥20000 %	Overall %
Iron	19.0	40.3	57.1	81.9	86.8	52.0
Radio	47.6	62.0	58.4	67.5	76.3	61.1
Karaoke Machine	3.2	17.6	24.2	42.2	63.2	24.6
Rice Cooker	1.6	2.8	11.8	31.3	60.5	13.4
Fan	28.6	60.2	78.3	92.8	100.0	69.3
Stove/Burner	1.6	4.2	2.5	10.8	42.1	7.0
Color TV	15.9	29.6	57.8	78.3	86.8	47.2
B/W TV	34.9	48.1	42.9	34.9	36.8	42.4
Video Player	1.6	10.2	29.2	57.8	81.6	26.6
Air Conditioner	1.6	1.4	1.9	14.5	28.9	5.3
Vacuum	0.0	1.4	0.6	9.6	21.1	3.6
Washing Machine	0.0	1.9	4.3	14.5	34.2	6.4
Sewing Machine	0.0	4.6	4.3	15.7	23.7	7.0
Stereo	9.5	18.1	28.0	38.6	57.9	25.7
Refrigerator	6.3	31.5	59.0	84.3	92.1	48.5
Water Heater	0.0	0.0	0.6	6.0	13.2	2.5
Freezer	0.0	0.9	2.5	3.6	13.2	2.9

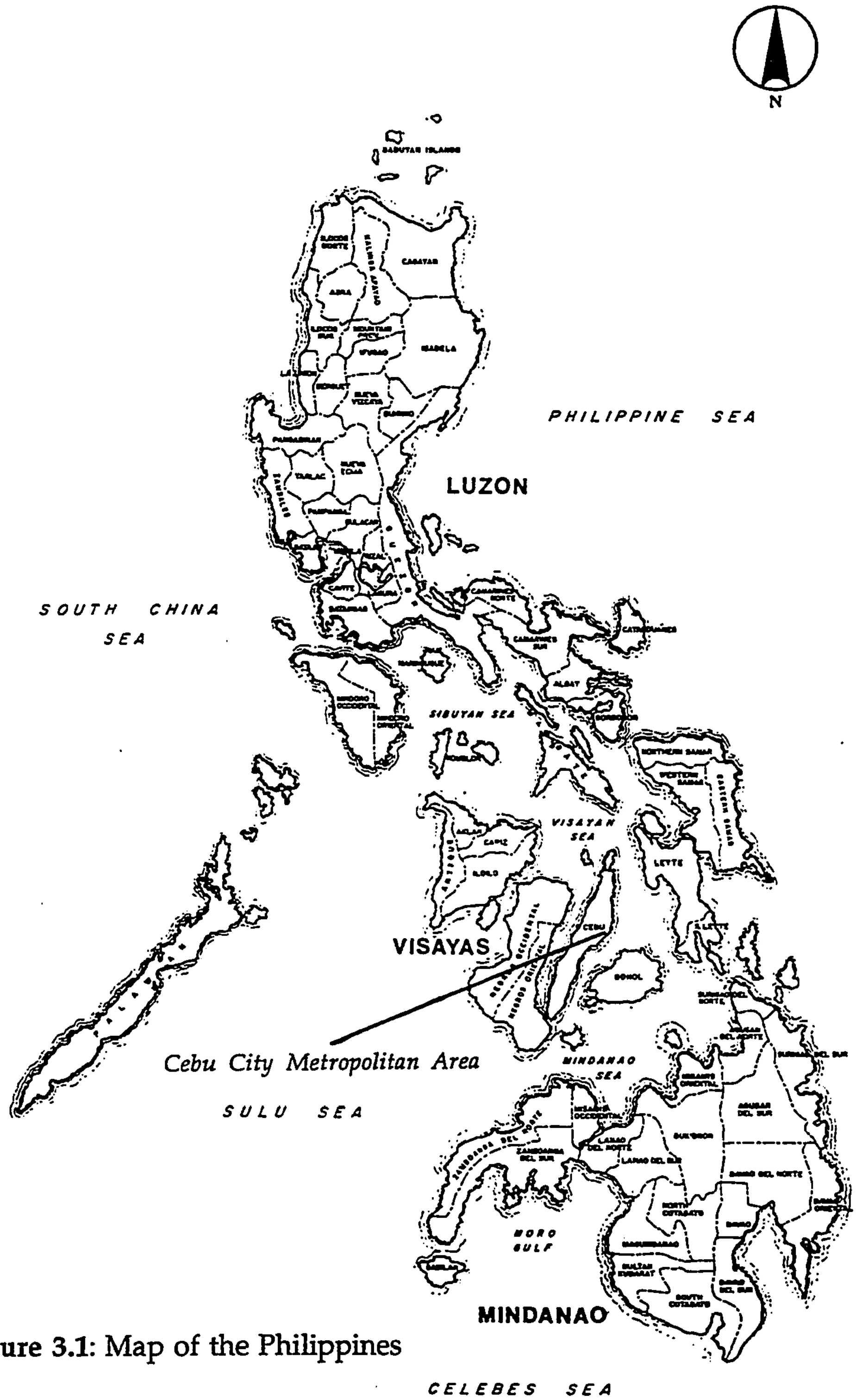


Figure 3.1: Map of the Philippines

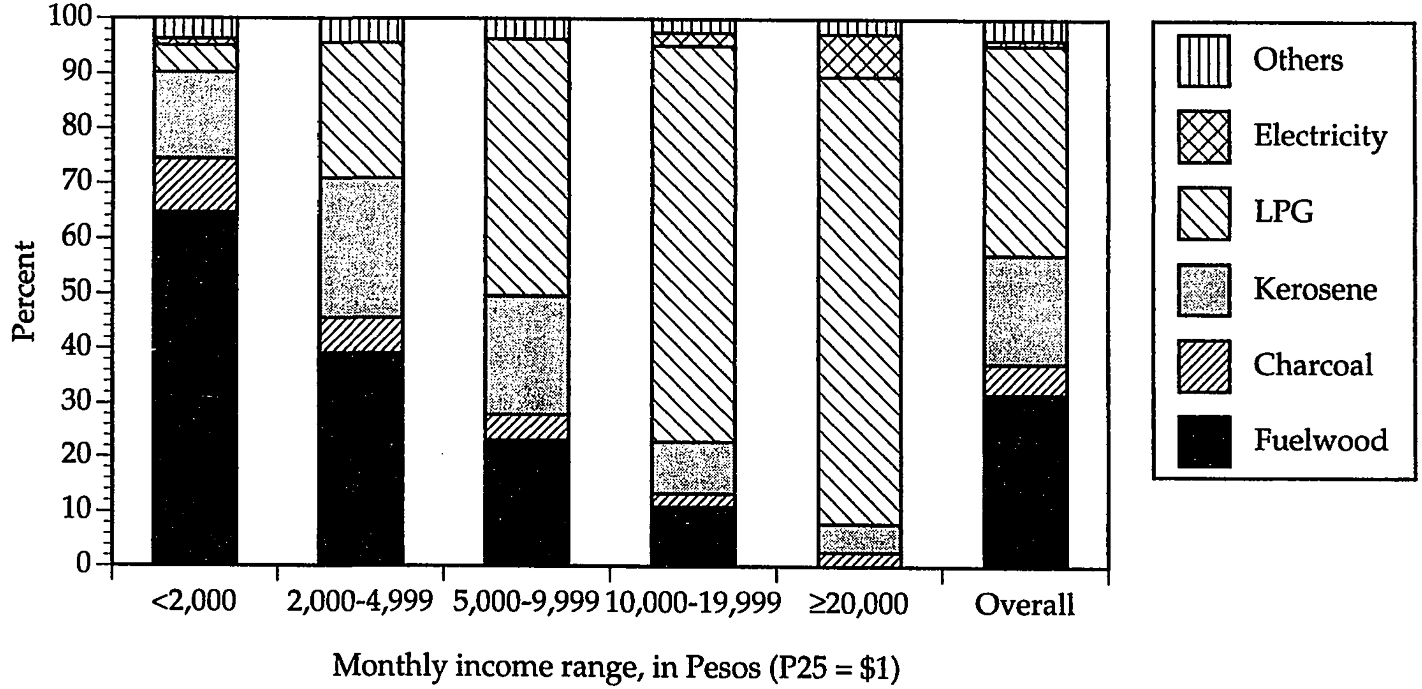


Figure 3.2: Primary cooking fuels of Cebu City households in 1992, by income category (in percent)[1]

1. The "other" category includes households using a combination of fuels near equally and those doing no cooking at all.

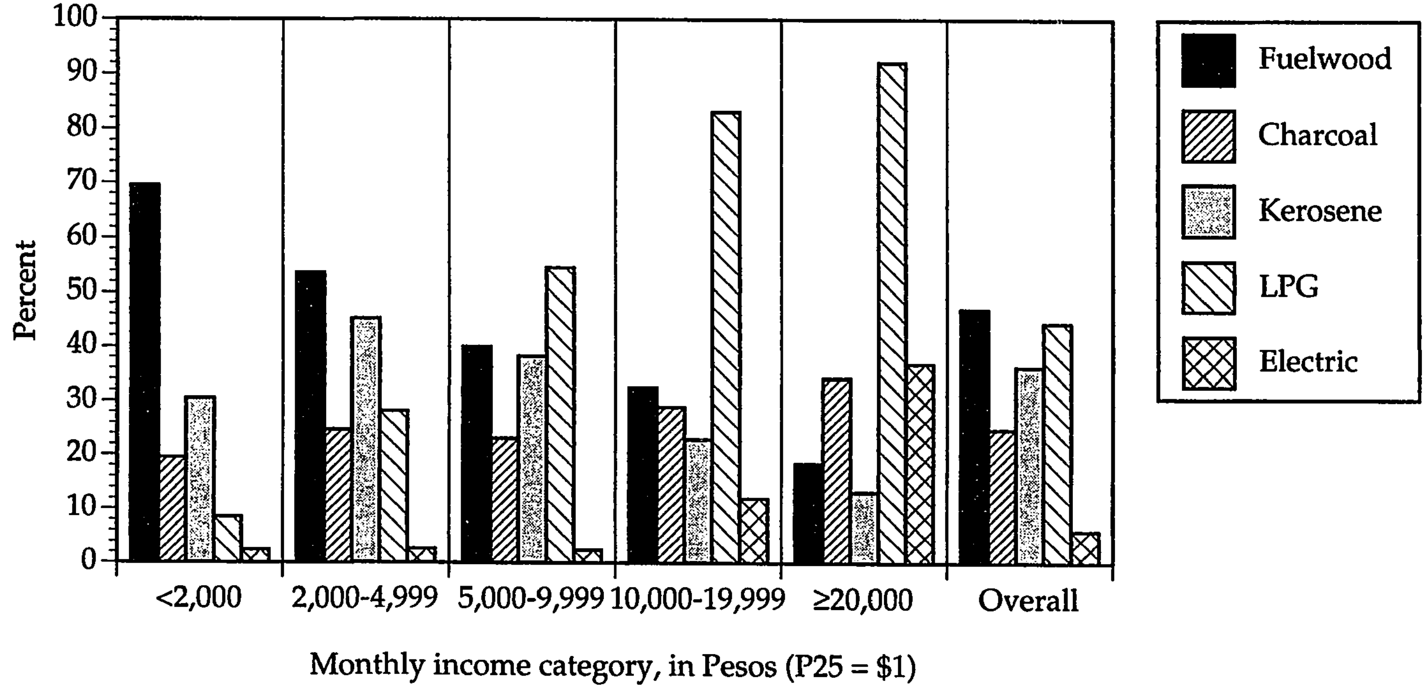


Figure 3.3: Stove ownership in Cebu City households by income category, in percent, 1992

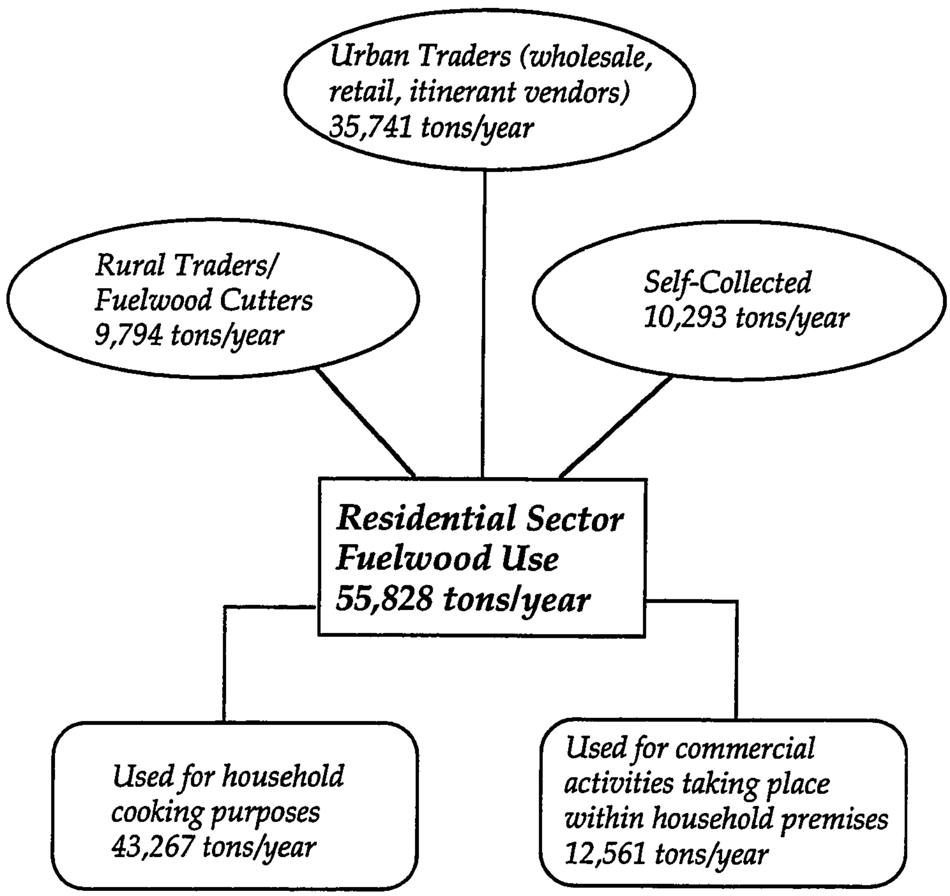


Figure 3.4: Sources and end-uses of fuelwood in the residential sector of Cebu City, 1992

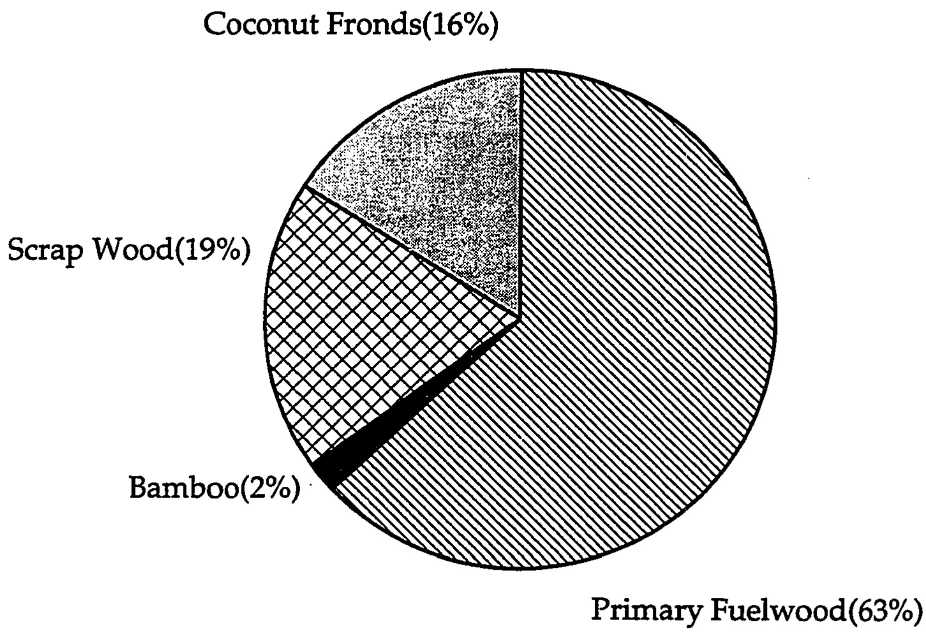


Figure 3.5: Relative contributions of woody/non-woody biomass and primary/secondary (scrap) wood to residential sector fuelwood requirements in Cebu City, 1992

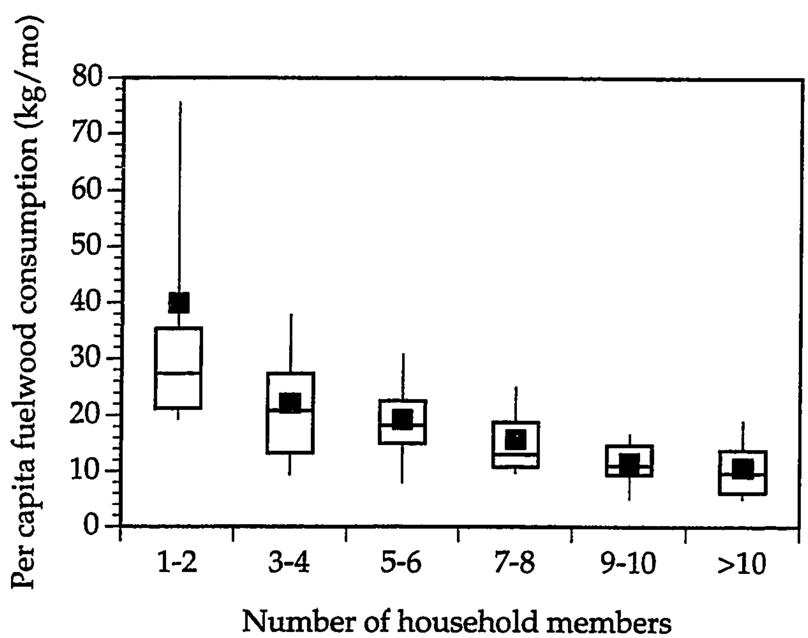


Figure 3.6: Household size and monthly per capita fuelwood consumption (in kg) for Cebu City households using fuelwood as their primary cooking fuel[1], 1992

1. The central boxes in the plot extend from the first to the third quartile, with the height of the box equalling the inter-quartile range of the distribution. The horizontal line within each box represents the median value of the sample, while the square indicates the mean. The vertical lines extending from the central box reach from the 10th percentile (bottom decile) to the 90th percentile (top decile). Outliers beyond these points are not shown, although they are included in the calculation of the mean, median and other statistics.

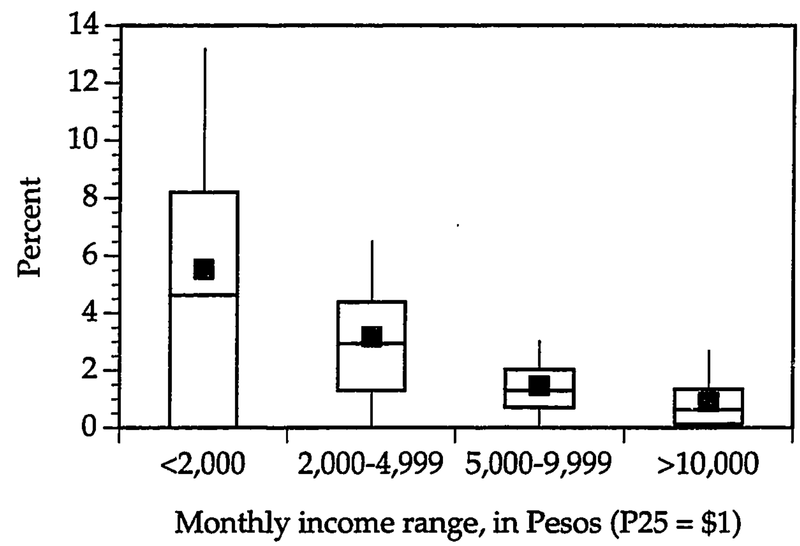


Figure 3.7: Percentage of monthly household income spent on fuelwood purchases for Cebu City households using fuelwood as their primary cooking fuel, by income category, 1992

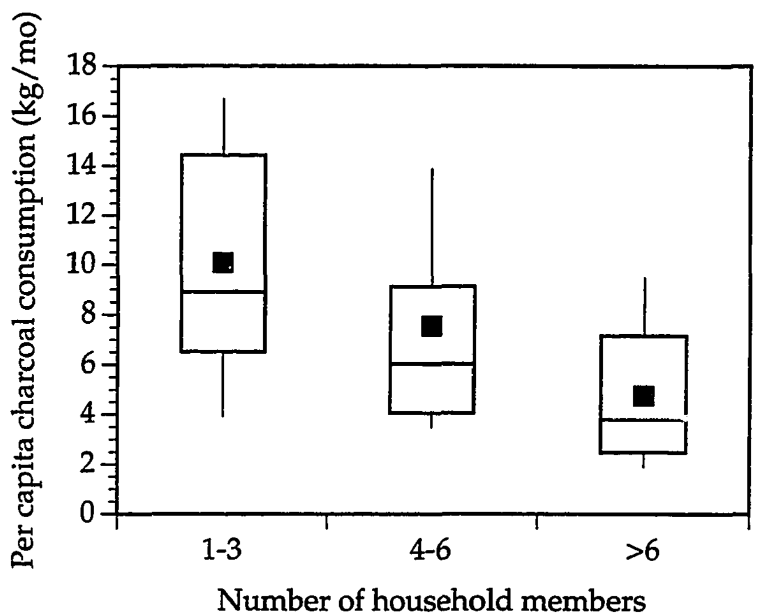


Figure 3.8: Household size and monthly per capita charcoal consumption (in kg) for Cebu City households using charcoal as their primary cooking fuel, 1992

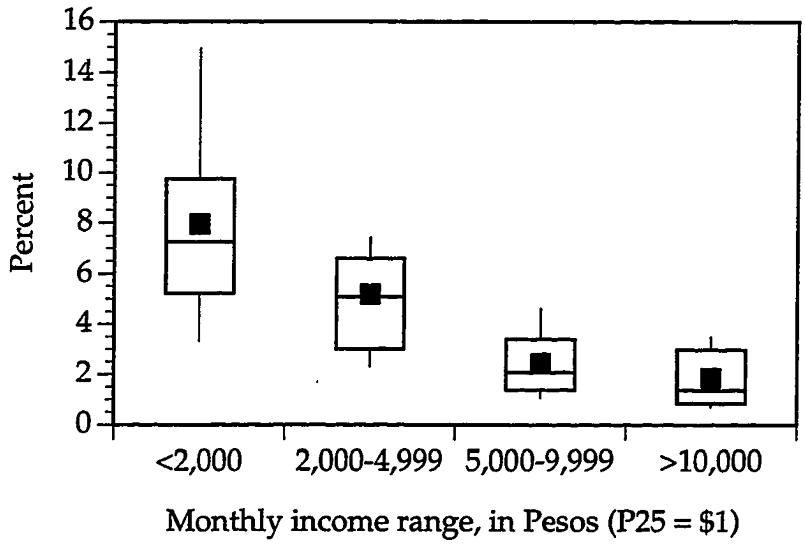


Figure 3.9: Percentage of monthly household income spent on charcoal purchases for Cebu City households using charcoal as their primary cooking fuel, by income category, 1992

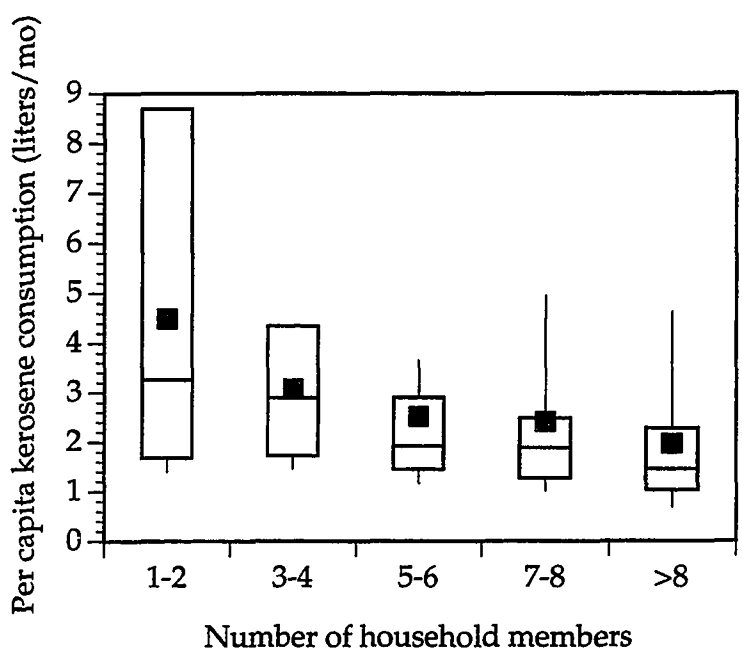


Figure 3.10: Household size and monthly per capita kerosene consumption (in liters) for Cebu City households using kerosene as their primary cooking fuel, 1992

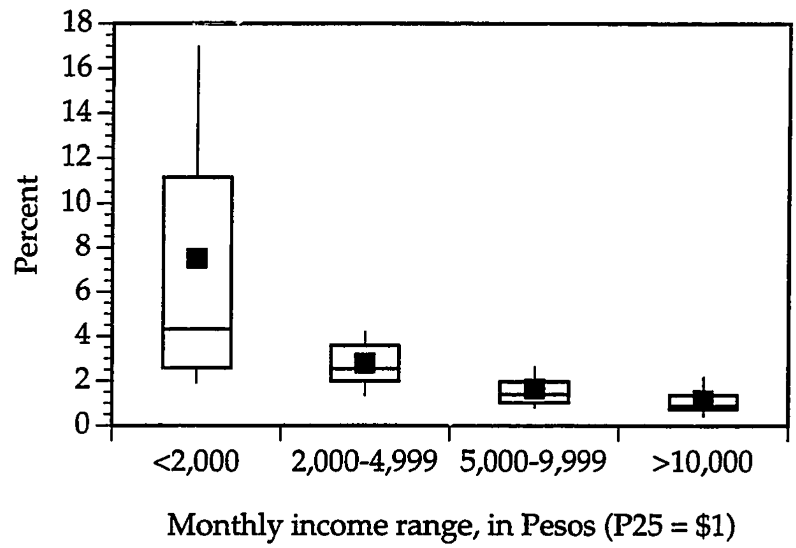


Figure 3.11: Percentage of monthly household income spent on kerosene purchase for Cebu City households using kerosene as their primary cooking fuel, by income category, 1992

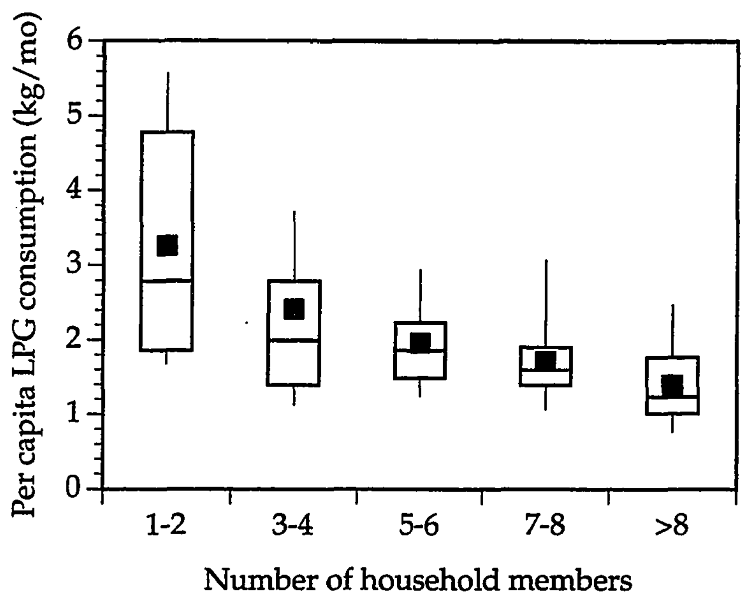


Figure 3.12: Household size and monthly per capita LPG consumption (in kg) for Cebu City households using LPG as their primary cooking fuel, 1992

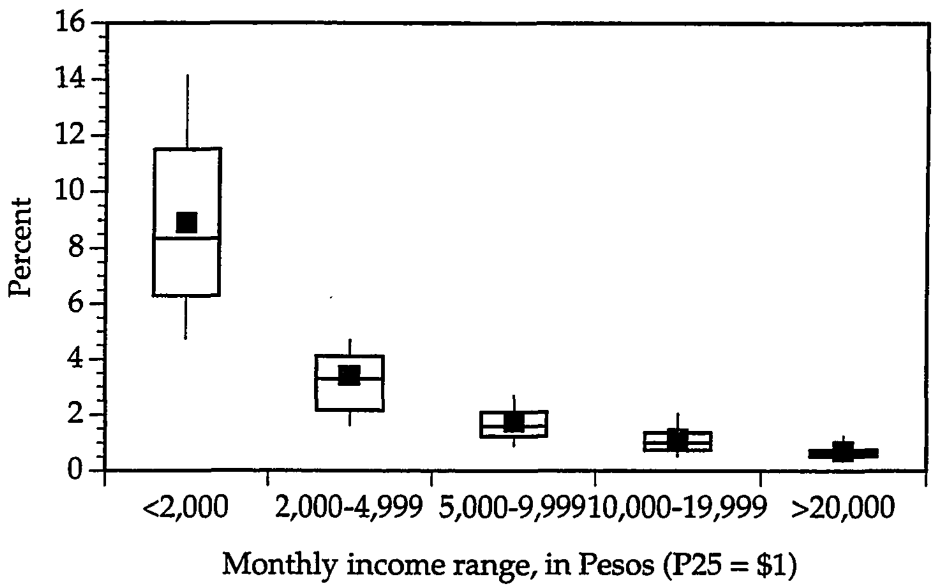


Figure 3.13: Percentage of monthly household income spent on LPG purchases for Cebu City households using LPG as their primary cooking fuel, by income category, 1992

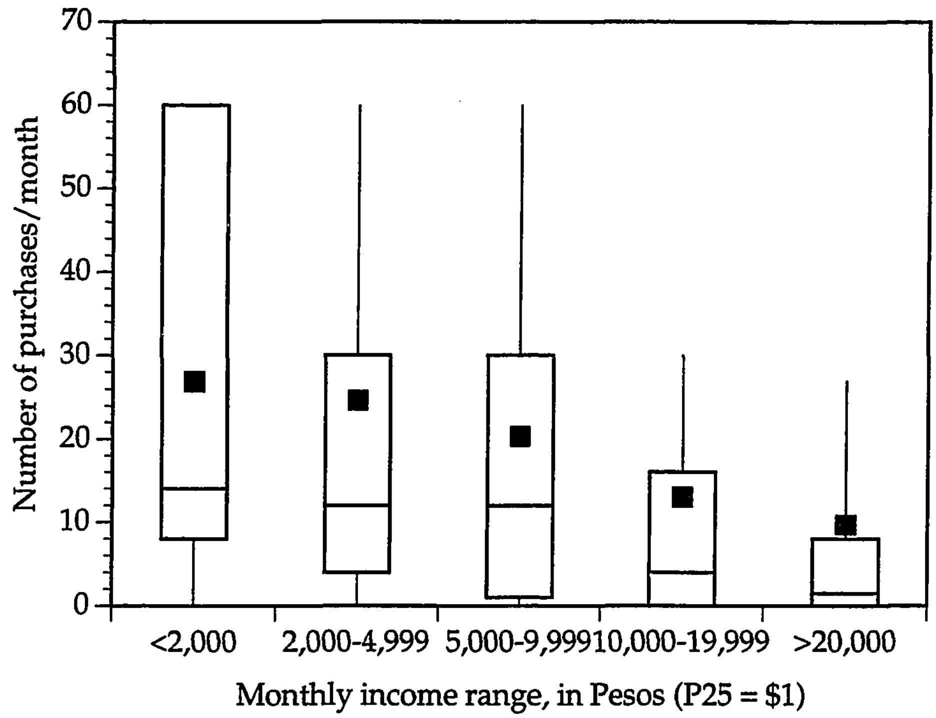
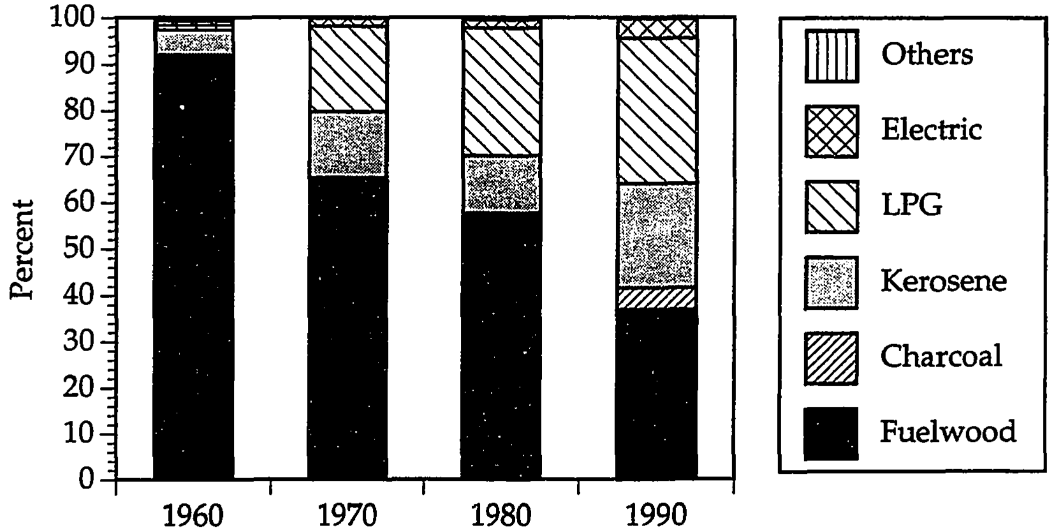
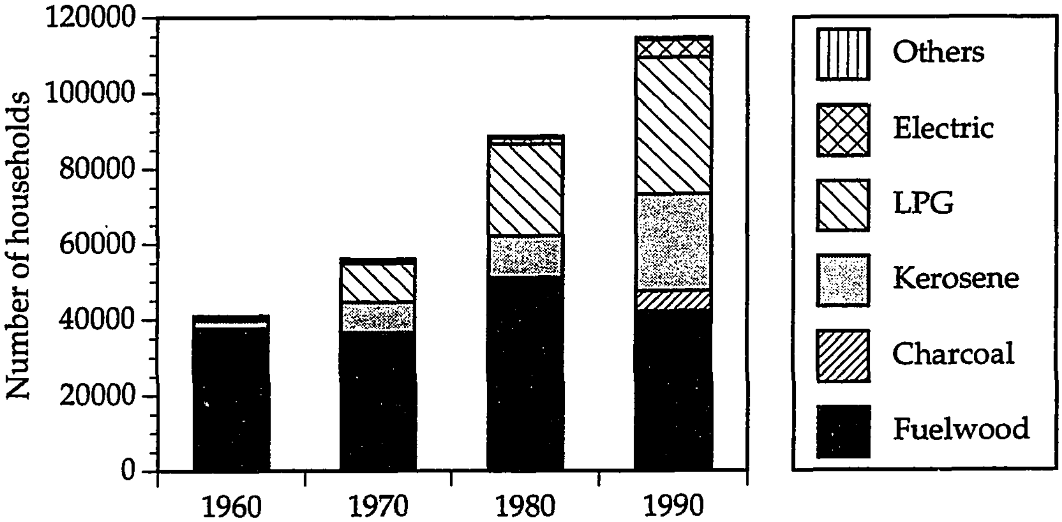


Figure 3.14: Frequency of household meal purchases from prepared food vendors in Cebu City, by income category, 1992



(a)



(b)

Figures 3.15a and b: Primary cooking fuels of Cebu City households, 1960-1990, in percent and number of using households. Sources: Jacobson 1969; BCS 1972; NCSO 1983; NSO 1992

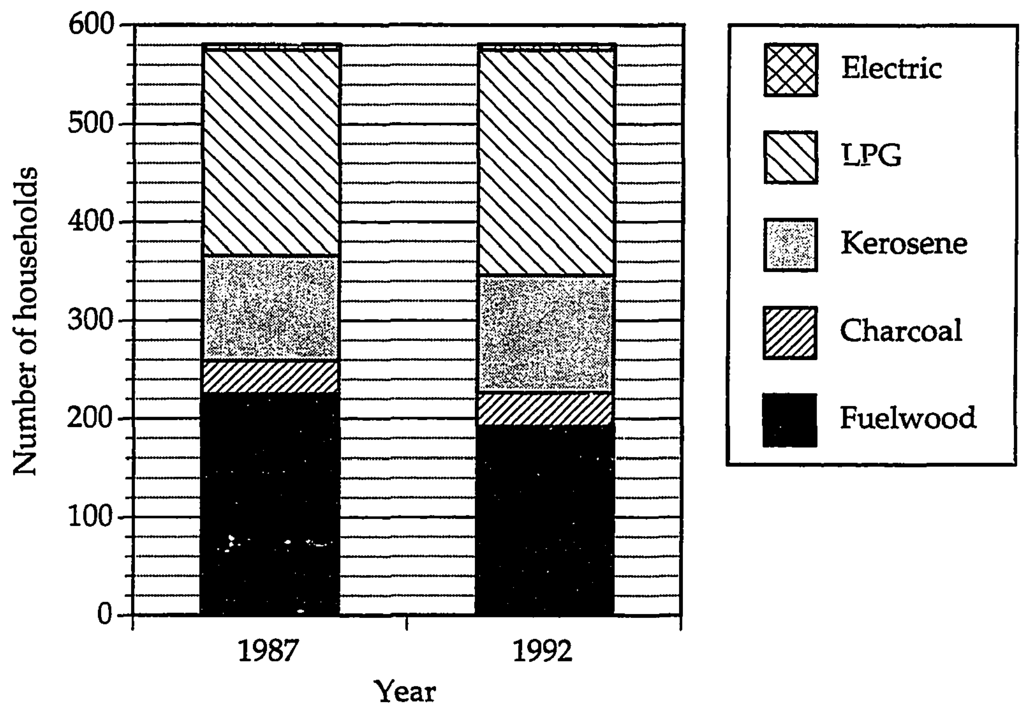


Figure 3.16: Changes in primary cooking fuels for a sample of 581 Cebu City households, 1987-1992

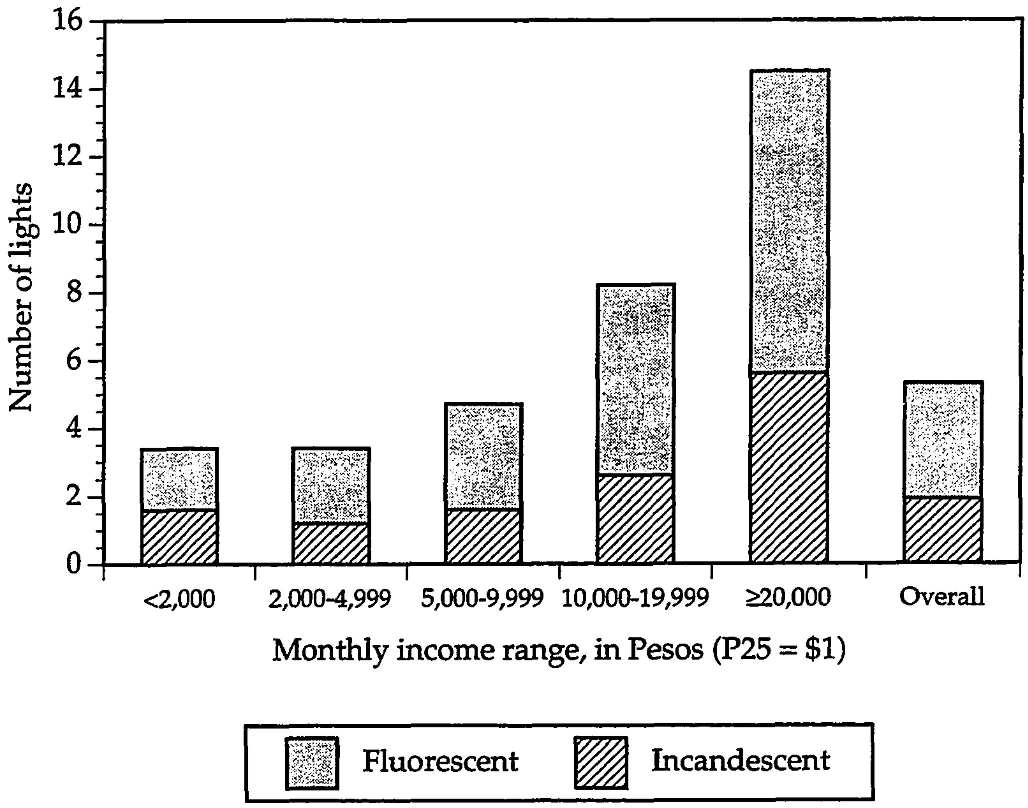


Figure 3.17: Average number of lights in use in Cebu City households, by income category and bulb type, 1992

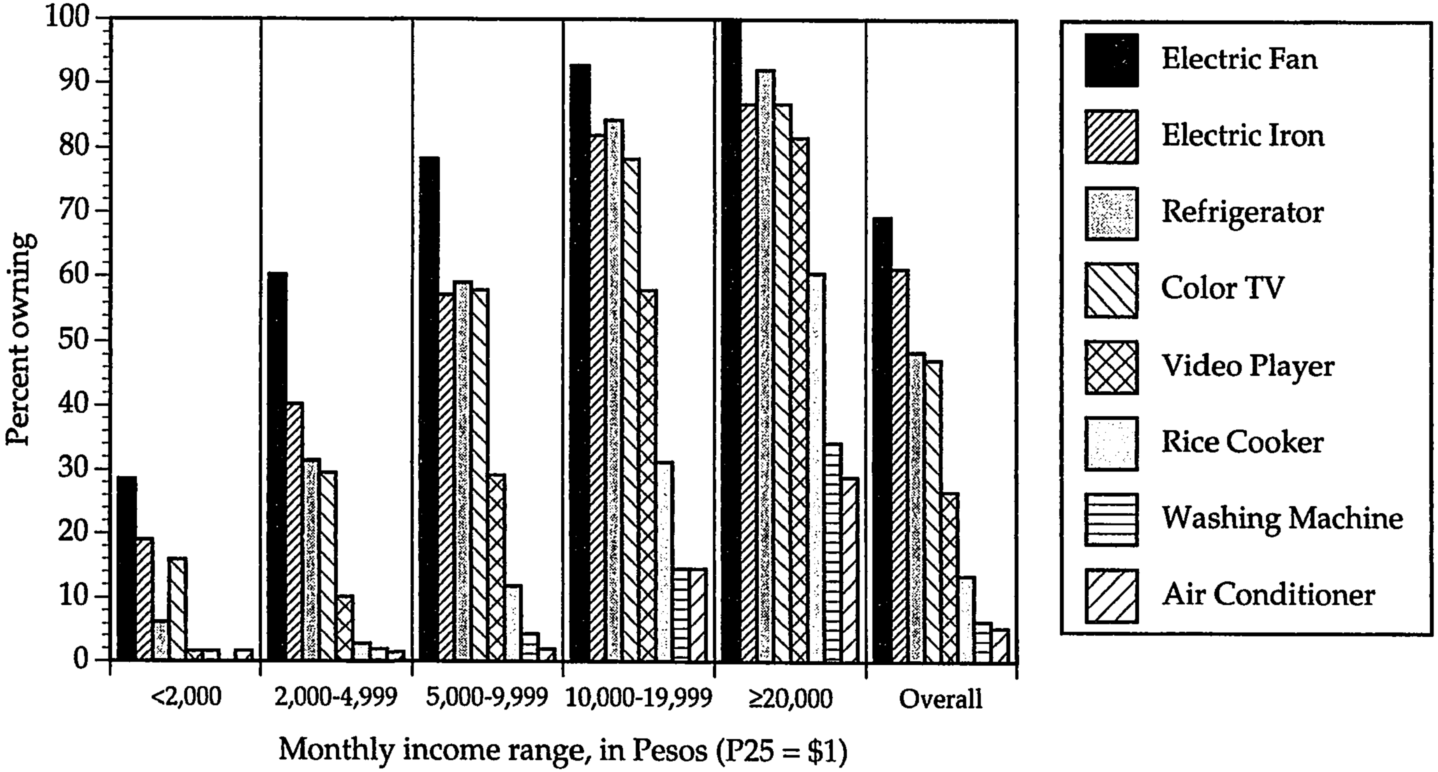


Figure 3.18: Appliance saturation rates in Cebu City households for eight commonly-owned electric devices, by income category, 1992

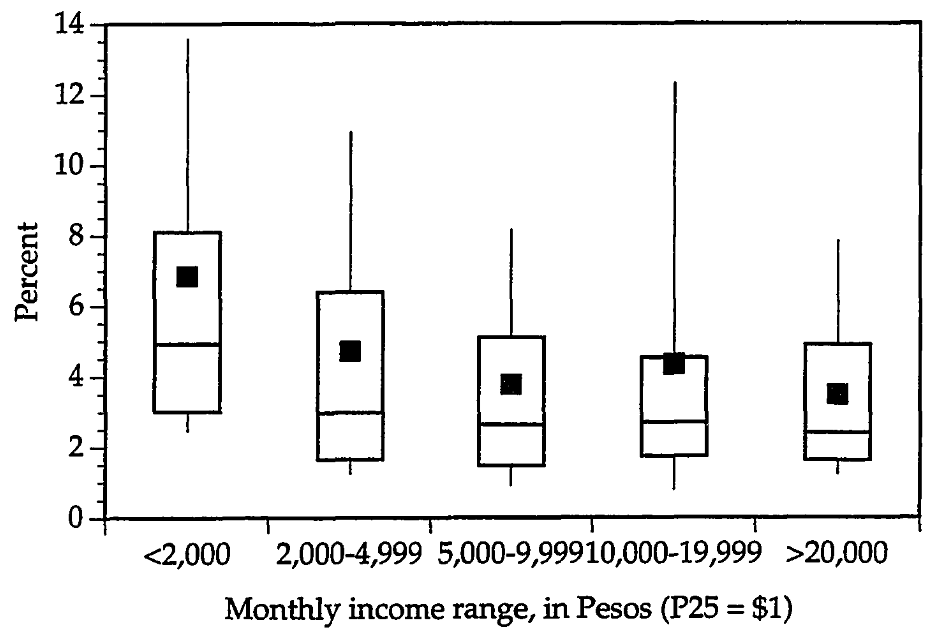


Figure 3.19: Percentage of monthly household income spent on electricity for electricity-using households in Cebu City, 1992

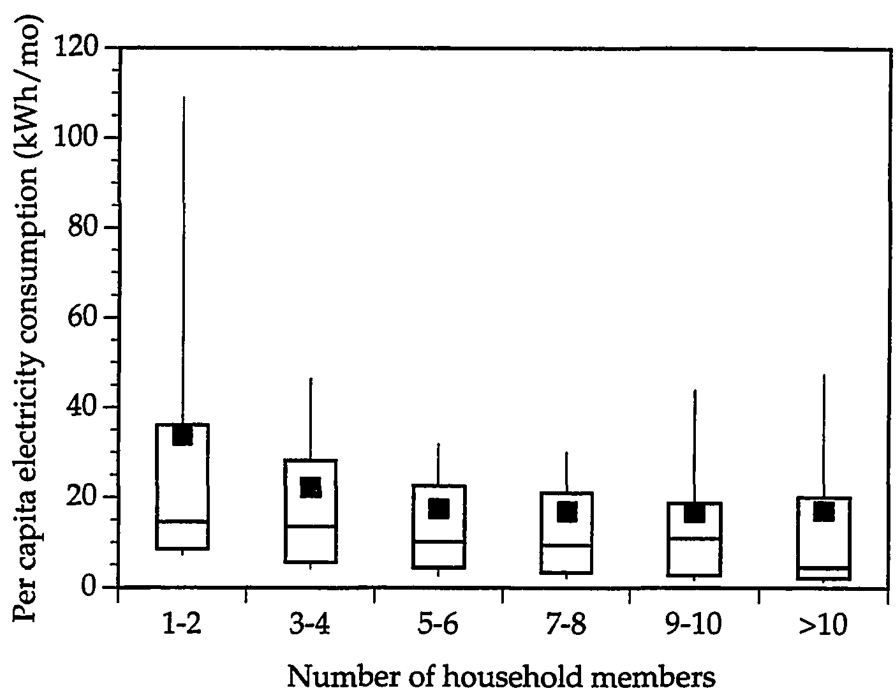


Figure 3.20: Household size and monthly per capita electricity consumption (in kilowatt-hours) for electricity-using households in Cebu City, 1992

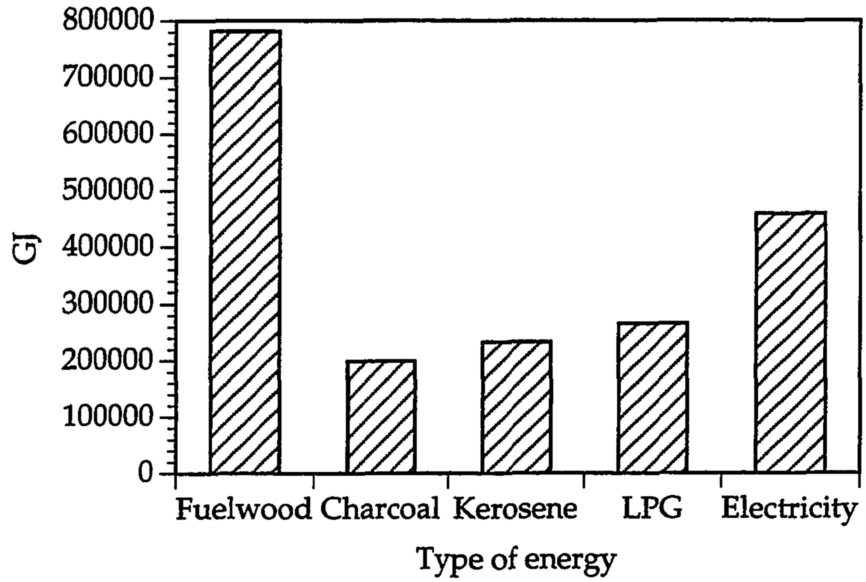


Figure 3.21: Energy consumption in the residential sector of Cebu City (in gigajoules or GJ), on an *input* basis, 1992

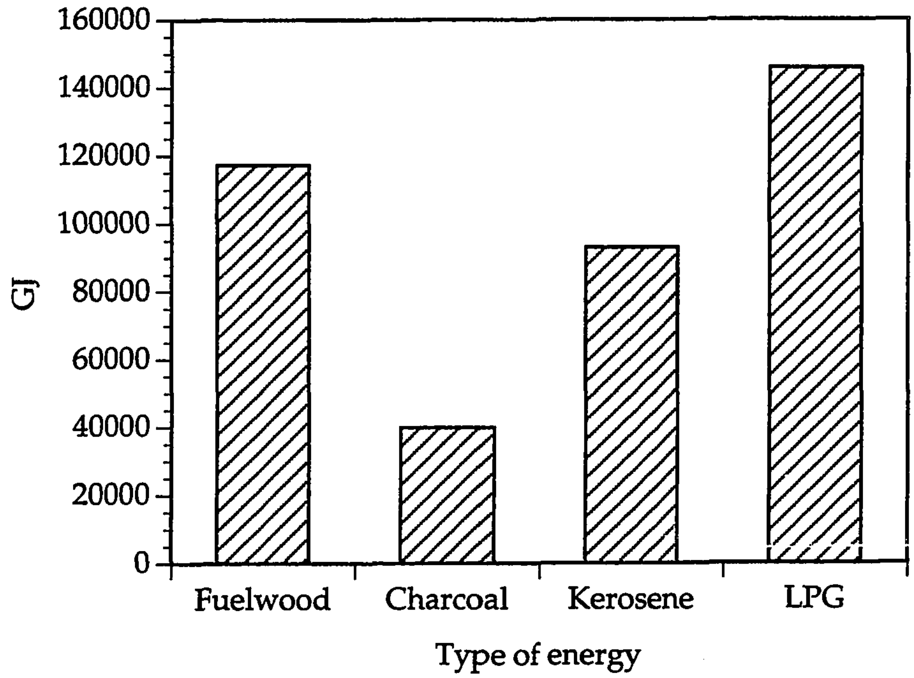


Figure 3.22: Residential sector consumption of cooking fuels in Cebu City on an *end-use or delivered-energy*[1] basis, in gigajoules (GJ), 1992

1. Adjusted energy figures based on the following assumed conversion efficiencies: Fuelwood (15%); Charcoal (20%); Kerosene (40%); LPG (55%).

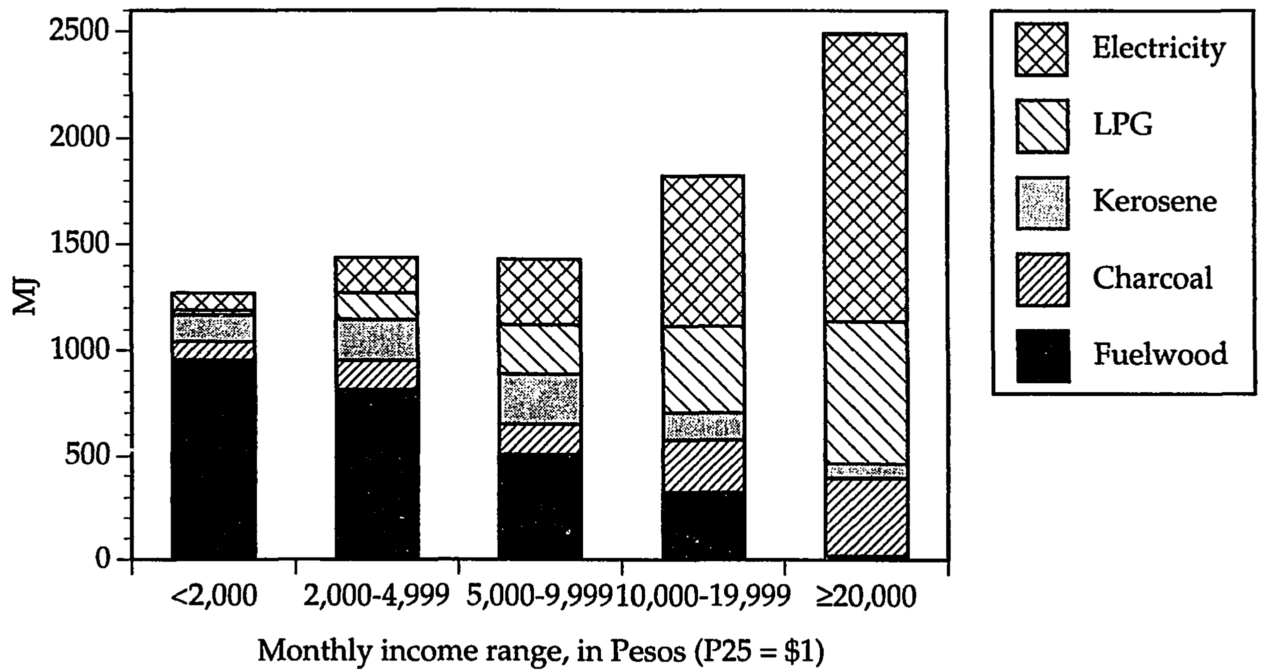


Figure 3.23a: Average monthly consumption of major energy forms in Cebu City households on an *input* basis, by income category, in megajoules (MJ)[1] per household, 1992

1. Reported household energy consumption converted into MJ as follows (Source: World Bank 1990), 1 kilogram of wood = 14MJ, 1 kilogram of charcoal = 25MJ, 1 liter of kerosene = 35.2MJ, 1 kilogram of LPG = 45.77MJ, 1 kilowatt-hour of electricity = 3.6MJ.

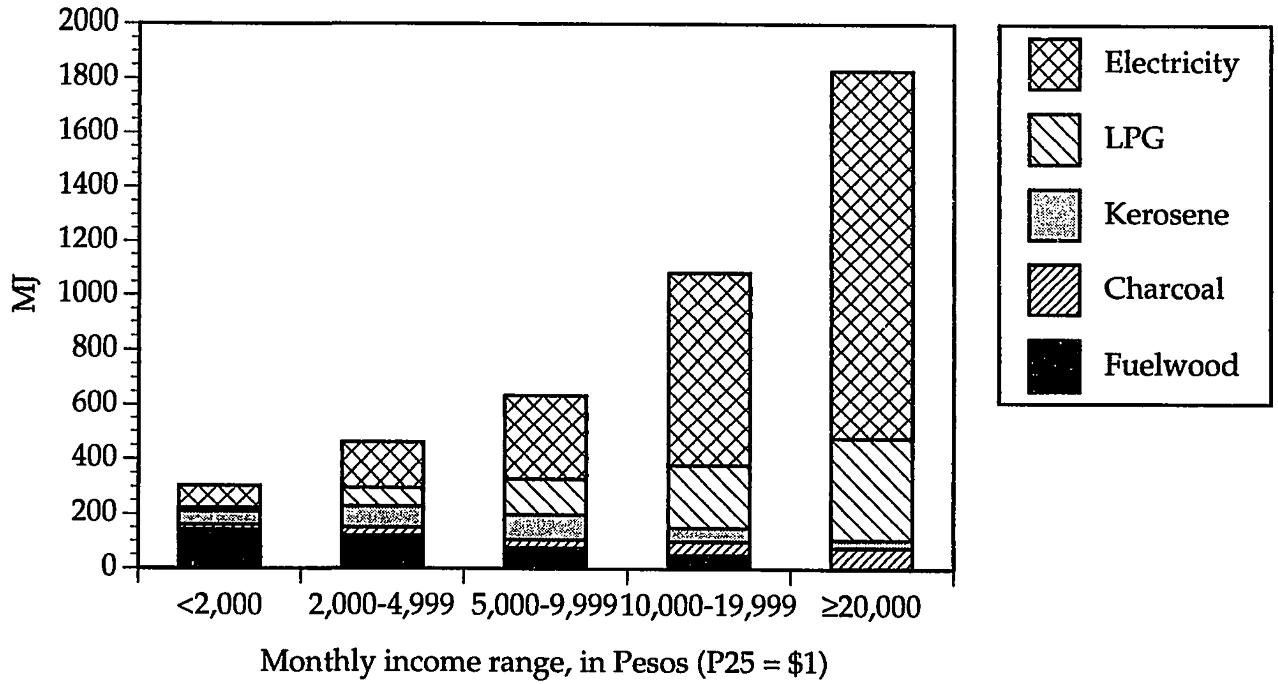


Figure 3.23b: Average monthly consumption of major energy forms in Cebu City households *on a delivered energy basis*, by income category, in megajoules (MJ)[1] per household, 1992

1. Input energy figures converted into useful or delivered energy using conversion efficiencies given in Figure 3.22.

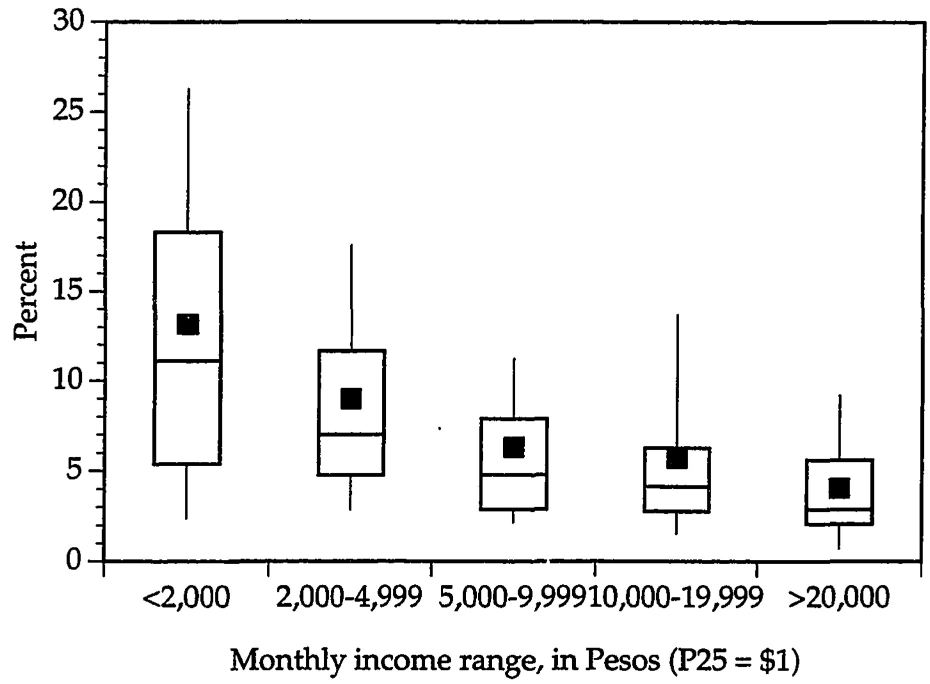


Figure 3.24: Percentage of monthly household income spent on all energy purchases of Cebu City households, by income category, 1992

APPENDIX A

URBAN WOODFUEL TRADER QUESTIONNAIRE

Section A: Description of Proprietorship

A.1 Address/location of proprietorship.
A.2 Physical description of establishment.
A.3 Nature of business including types of commodities being sold.

Section B: Proprietor (Respondent) and Business Information

B.1/B.2/B.3 Name/Age/Sex of respondent.
B.4 Educational attainment of respondent.
B.5 What is the ownership structure of the business and where does respondent fit in?
B.6 What is the primary occupation of the respondent and/or the owner?
B.7 What other family members are involved in the business and on what basis?
B.8 How long has the proprietor and/or respondent been living in Cebu City?
B.9 How long has the proprietor and/or respondent been engaged in the woodfuel business?
B.10 How did the proprietor and/or respondent get into the woodfuel business?
B.11 How long does the proprietor and/or respondent intend to stay in the business and why?

Section C: Sales Patterns

C.1 Does the respondent notice any seasonality to sales? If yes, explain.
C.2 Does the respondent have customers that only purchase woodfuels on special occasions but that otherwise they do not see?
C.3 Have there been any events in the recent past that have affected sales markedly? If yes, explain.
C.4 What are some average sales volumes for the establishment on a daily/weekly/monthly basis? How widely do these sales volumes fluctuate during the periods mentioned in C.1 and C.3?

C.5 What is the amount of stock on hand at present? Is this approximately the usual level? How widely do stocks kept on hand fluctuate?

C.6 Who are the regular customers of this establishment? Approximately how many of each and what are the volumes purchased by each sector as a percentage of total sales?

C.7 If the establishment sells to commercial/industrial users what are the names and locations of these businesses?

C.8 If the establishment sells to households what are some of the typical purchase patterns encountered?

C.9 Is the number of household customers and the volume they purchase increasing, decreasing or staying the same? What about commercial/industrial users? Why?

C.10 If charcoal is sold, who are the main buyers and what are the end-uses for this charcoal?

C.11 If the business sells woodfuel stoves what are the prices and characteristics of these?

C.12 (For enumerator) Would you classify the sales patterns of this business as mostly wholesale, mostly retail, or some combination?

Section D: Supply Patterns

D.1 What areas of the city and/or province are supplies being sourced from?

D.2 What is the approximate percentage of wood and charcoal originating from each area if more than one?

D.3 How are supplies usually delivered?

D.4 To what extent are supplies being sourced from *within* the city (e.g. from other traders)?

D.5 Can the respondent give names and approximate locations of their main suppliers?

D.6 How regular are deliveries and on what days of the week or hour of the day do they usually take place?

D.7 Do suppliers always deliver a regular amount or do traders order certain amounts?

D.8 Do suppliers sell on a cash basis only?

D.9 How long-term are relations between suppliers and the trader?

D.10 Does the trader know anything about how their suppliers obtain their stocks in the rural areas?

D.11 Does the respondent perceive any changes in the usual supply areas over the years, or do woodfuels still originate from the same areas as before?

D.12 Does the respondent perceive any changes in the ease of obtaining supplies over the years? If yes, explain when and how things changed.

D.13 Have there been any events in the recent past that have affected supply markedly? Any noticeable gluts or shortages?

D.14 Is there any seasonality to supply in terms of quantities, quality, prices, etc.? If yes, explain.

D.15 Does the respondent have any knowledge of the types of lands from which the woodfuels they sell originate?

D.16 Does the respondent have any opinion on whether urban woodfuel use has any environmental impact on rural areas? If yes, how will this affect future supplies?

Section E: Transportation Patterns

E.1 What is the usual mode of transport used in getting woodfuels to the trader?

E.2 How frequently are supplies delivered and what are the usual quantities delivered?

E.3 How would the respondent describe the type, size, and condition of the delivering vehicle?

E.4 Can the respondent estimate the maximum loads of the vehicles used?

E.5 Who shoulders the transportation expenses?

E.6 Are woodfuels delivered from the trader to other traders and/or customers within the city? If yes, what are the transportation modes used, who pays for these, and how much do they carry?

Section F: Fuel Characteristics

F.1 Can the respondent give an approximate breakdown of their sales on the basis of fuelwood types (e.g. coconut fronds, *primary fuelwood*, split bamboo)?

F.2 For *primary* fuelwood can the respondent give an approximate breakdown of the species being sold?

F.3 Are there any sales of unusual or special types of woodfuels (e.g. mangrove wood, molave)? Are there specific customers that have a preference for certain types of woodfuels?

F.4 Does the respondent use any particular terminology to distinguish between the different types and sizes of fuelwood bundles, sacks of charcoal, etc.?

F.5 Has the respondent perceived any changes in the quality of woodfuels over the years?

F.6 Has the respondent perceived any changes in the quality of woodfuels during different seasons?

F.7 Can the respondent estimate the percentage of a sack of charcoal that ends up as fines? Are there any uses for these fines?

F.8 (For enumerator) Weighings should be conducted of a sample of stocks on hand and recorded in conjunction with prices and other characteristics of the sample including sizes, species and general condition.

Section G: Pricing Patterns

G.1 Can the respondent give a historical recollection of woodfuel prices in relation to the fuels being sold?
G.2 What were the prices paid for stocks currently on hand? What prices are being charged?
G.3 Is there a system for price mark-ups, or do these vary based on customer, types of fuels sold, etc.?
G.4 Do prices vary based on quantities purchased, are there discounts for large purchases?
G.5 To what extent does the trader practice break of bulk, or re-packing and re-bundling of stocks?
G.6 If they do practice break of bulk then how is this done? What are the relative price differences before and after? Are there any tricks to re-packing or re-bundling woodfuels?
G.7 Has the respondent perceived any fluctuation in prices of woodfuels in response to changes for conventional fuels such as LPG and kerosene?
G.8 Has the respondent perceived any seasonal fluctuation in the prices they pay and charge?

Section H: Operating Patterns/Costs

H.1 What is the number of people working in the establishment and on what basis? How much are they paid? What do they do? How are they related to the respondent/owner?
H.2 Does the business own, rent or squat on the land they are operating from? If rented, what is monthly rent? If owned, can the respondent estimate imputed monthly rental value?
H.3 Does the establishment have to pay taxes or fees to the city government or others in order to operate?
H.4 Are permits required from other entities like the DENR? Has the trader ever experienced any harassment from officials of any government agency?
H.5 Are all of the stocks of wood and charcoal stored on the premises, or are there other storage areas? If yes, where are these and how much do they cost?
H.6 Is there much loss of stock due to theft? Wastage? Other losses?

H.7 If the establishment practices break of bulk, how much labor and material are put into this effort?
H.8 What are the usual hours and days of operation and are they in business year-round?
H.9 Is there a need for drying of wood at their stage or is wood delivered ready to be sold?
H.10 Are there any other costs associated with the trade not covered above (e.g. purchases of tools, sacks for charcoal, etc.)?
H.11 Where did the capital used to start the business come from?
H.12 What percentage of the respondent's income comes from woodfuel sales as opposed to sales of other commodities or other occupations?

Section I: Conclusion/Miscellaneous Questions

I.1 Can the respondent provide us with any information on other woodfuel dealers in their area, or the existence of a *tabo* or irregular market where woodfuels are sold?
I.2 How intense does the respondent feel the competition is between traders and has this changed much over the years?
I.3 Could the respondent give us an estimate of the average monthly income they derive from the sale of woodfuels (net)?
I.4 Would the respondent be agreeable to regular monitoring of prices and weights of their supplies by staff members of the USC-ANEC in the future?

APPENDIX B

HOUSEHOLD ENERGY SURVEY DESIGN AND IMPLEMENTATION

The design and implementation of the Cebu City household energy survey involved the following basic procedures: 1) choosing an appropriate and feasible sampling method; 2) determining an optimal sample size based on offsetting considerations of a desire for accuracy and the need to work with limited resources; 3) selecting the actual sample of respondent households; 4) developing and testing an effective survey instrument (questionnaire); 5) recruiting and training field personnel and supervising the actual conduct of the survey, and; 6) editing and encoding the completed questionnaires. Each of these steps is discussed below.

The sampling method adopted for the survey is best classified as a proportional stratified sample, with the 49 urban *barangays* of Cebu City representing individual strata, and the number of respondents chosen from each *barangay* in direct proportion to the size of the household population in each relative to the overall city total. The sampling approach was chosen based on the following considerations. First, a necessary requirement was that our sampling approach be probabilistic in order to allow us to reach broader inferences of household energy use patterns in the city based on information obtained from the sample responses. Second, the decision to use *barangay* as strata — and to ensure that the relative proportion of respondents from each *barangay* in the sample matched the proportion of households in that *barangay* to total household population — was made based on a desire to ensure the representativeness of the sample. This was important since it was felt that different areas would show variations in energy use patterns based on unique socioeconomic and settlement characteristics, and that a simple random or cluster sampling approach could not guarantee that representativeness. Third, the use of *barangay* as strata was necessitated by the absence of any existing information that would enable us to stratify the population on the basis of income or other socioeconomic characteristics, whereas we *did* have access to the master list of households compiled by the National Census and Statistics Office (NCSO) – 1990 Census of Population and Housing. These lists broke the city's population down by *barangay*, and provided information on household location, name of household head, and number of household members. Overall, the sampling approach adopted was intended to provide the necessary element of randomness to enable extrapolation of survey results to the wider population, while simultaneously ensuring enough representativeness to be able to address energy use characteristics of specific sub-sectors of the population. In addition, information gathered from the survey allowed for post-stratification of the original sample on the basis of a variety of household characteristics (e.g.

income, household size, type of dwelling), as well as multi-phase sampling of any portion of the original sample.

Next, a series of sample size calculations were made for deriving estimates of population parameters — ranging from the percentage of households using charcoal or LPG, to per capita monthly fuelwood consumption — based on variations in the desired level of confidence and allowable errors. Generally, for estimating population proportions (such as the proportion of the population using fuelwood) at a 95% confidence level, with a permissible error of 5%, a sample size of from 300-400 was determined to be satisfactory. At the other extreme, required sample sizes for estimating highly variable population parameters — such as per capita monthly fuelwood consumption — tended to be much higher depending on the confidence level and allowable error chosen. For instance, a preliminary estimate of the population standard deviation for per capita fuelwood consumption was derived from earlier surveys conducted by the University of San Carlos in rural regions of the province. Based on this figure, a desired 95% confidence level, and an allowable error in the sample mean of 1.5 kg/month (5% of the estimated population mean of 30 kg/month), a sample size of 1,338 was called for. This sample size was judged to be too large given our limited resources, and so the allowable error in the sample mean was adjusted to 2.4 (8% of the estimated population mean), yielding a sample size of 523. In the end, a sample size of 600 was selected on the basis of the exercises described above, as well as on an appraisal of our resources. In addition, a decision was made to select a total of 1,100 households from the census records, 600 for actual survey and 500 to serve as replacements for refusals or missing households, as well as to enable an expansion of the sample size at a later date if an analysis of the data suggested a need for it.

After determining the sample size and receiving permission from the NCSO to access the census master lists, the actual process of respondent selection was started using the following systematic sampling procedure. First, the household population of each *barangay* (N_b) was divided by the total household population in the city (N_c), yielding a proportional value ($N_b \div N_c = P$). This value (P) was multiplied by the desired sample size (S) of 1,100 (including replacements) in order to determine the number of households to be drawn from each *barangay* (n_b). The total number of households in each *barangay* (N_b) was then divided by the number of households to be selected in each (n_b), yielding an "interval" number (i) which was usually close to 93. This number represents nothing more than the total number of households in Cebu City (102,446) divided by the number of samples to be drawn (1,100), although rounding differences necessitated that it be computed separately for each *barangay*. A random numbers table was then consulted to yield a starting number (j) between 1 and 93 (or i) for each *barangay*. This number was used to select the first household from each *barangay* master list. Following that, household number i + j was selected, proceeded by 2i + j and so on until the desired number of respondents was selected for each *barangay*. Finally, 54.5% (600 ÷ 1,100) of the selected households in each *barangay* were then re-selected on a random basis for interview, with the remainder randomly ordered to serve as replacements and/or additional respondents if needed.

The selection process can be better described by way of an example and by expressing it as follows:

$$N_b \div N_c = P \quad (1)$$

$$P_b\ (S) = n_b \quad (2)$$

$$N_b \div n_b = i \quad (3)$$

where,

N_b = total number of households in a given *barangay*

N_c = total number of households in the city

P_b = proportion of sample to be drawn from a given *barangay*

S = sample size (including replacements), or 1,100

n_b = number of households selected as respondents from a given *barangay*

i = inverse of the proportion of households being selected in a given *barangay*, approximately equal to $N_c \div S$ or 93, used as an "interval" number

j = random number between 1 and 93 (or i) drawn in order to select the first respondent from a given *barangay* list

As an example, take the case of *Barangay* Mambaling, household population 4,211.

$N_b \div N_c = P_b$	or	$4{,}211 \div 102{,}446 = .0411$	(1)
$P_b\ (S) = n_b$	or	$.0411\ (1{,}100) = 45.2$	(2)
$N_b \div n_b = i$	or	$4{,}211 \div 45.2 = 93.2$	(3)

The total number of households to be selected in Mambaling is 45, and an initial random number (j) of 66 was selected. Therefore, the 66th household on the master list for *Barangay* Mambaling was selected, followed by the 159th (66 + 93), the 252nd (66 + (2)93), the 345th (66 + (3)93), and so on. Finally, 25 (or 54.5%) of the 45 households initially selected were re-selected on a random basis for actual interview, with the remaining 20 listed in random order as potential replacements or future additional respondents.

Development of the questionnaire for use in the survey was an iterative process spread out over a number of months. Early drafts of the questionnaire borrowed from samples of questionnaires used in earlier household energy surveys in places like Hyderabad, India (Macauley *et al.* 1989; Alam *et al.* 1985b), Java, Indonesia (World Bank 1990), northern Nigeria (Hyman 1991) and Ilocos Norte, Philippines (Hyman 1985), as well as from personal communication with the authors of these surveys. Use was also made of a number of published sources dealing with the collection of survey data in developing countries in general (such as Casley and Lury 1987), and with designing household energy surveys in particular (Hyman 1983c; Leach and Gowen 1987; Leitman 1988). Finally, standard texts on the subject of survey instrument design were also consulted (see for example, Converse and Presser 1990).

Later drafts of the questionnaire were pre-tested and modified as needed. The final questionnaire was 54 pages in length (see Appendix C for an outline), and contained questions on basic socioeconomic and demographic characteristics of the household, fuel-use and purchase patterns, preferences for specific fuels, cooking practices, appliance ownership, stove ownership and use, and recent fuel-switching practices of the household. The length of the questionnaire reflected a number of decisions made in advance that we believe increased the accuracy of the survey and hence the reliability of the results. For example, questions were listed in both English and Cebuano (the local dialect), since we determined that even trained enumerators proficient in English tended to give varying translations and interpretations to the same question. Second, plenty of spacing was provided between questions in order to minimize the possibility of recording errors, missed questions, and eventually, encoding errors. Third, pre-tests revealed that a number of questions actually required two or even three different pieces of information (so-called "double-barreled" questions), and these were subsequently divided into single questions thus expanding the size of the questionnaire. Despite its length, the questionnaire took only an average of 25-30 minutes to administer due to a combination of careful enumerator training, easy-to-follow skipping patterns between sections, and a predominance of pre-coded questions in the survey which enabled quicker recording of responses.

Ten enumerators were hired and trained to carry out the actual interviewing. The enumerators were divided into five teams of two, with each team consisting of at least one female member since prior experience indicated that this would ensure better access and rapport with female heads of households, typically the more common respondents. The use of two enumerators allowed for one to focus on asking the questions directly, while the other could listen for inconsistencies, record additional observations of the interview or surroundings, and assist with follow-up questions. An experienced field supervisor was hired full-time to accompany the teams on a rotating basis in order to ensure that the surveys were conducted in a consistent manner by all of the teams, and that the enumerators were not "leading" respondents or skipping relevant questions. In addition, the field supervisor conducted random spot checks of surveyed households in order to verify the accuracy of responses and ensure that all interviews were actually conducted. Each survey team carried with them an interviewer manual, flash cards to aid the respondent in answering questions with pre-coded responses, portable weighing scales to make estimates of woodfuel consumption, and a small token of appreciation (such as a bar of soap) to be given to the respondent at the completion of the interview. Interview teams also carried with them a letter of introduction from the study leaders, picture ID, and a signed authorization earlier obtained from each *Barangay* Captain in order to reassure the respondent of their purpose. As a result, refusal rates were relatively low (4.3%).

Estimates of household energy consumption were derived through a combination of respondent recall and direct measurement depending on the fuel in question. In the case of measuring fuelwood and charcoal consumption, our original intention was to use a technique practiced in at least two other household energy surveys that we were aware of (see Wijesinghe 1984; Hyman 1991). This technique requires the respondent to set aside enough wood and/or charcoal during the time of the interview for a few days usage, with this amount being weighed and recorded. The survey team then returns to the household (typically 24 and 48 hours later) and reweighs the wood and/or charcoal to determine daily consumption. We attempted to practice this technique during the pre-test but in many cases found that the respondent did not have enough wood on hand to last for 24, let alone 48 hours. As a result, we used both recall and direct weighing in combination. This involved first asking the respondent how much wood or charcoal they consume in a typical day, week or month, letting the respondent choose the timeframe and the unit of measurement they are most comfortable with (such as one bundle a day or one sack a month). The respondent is then asked if they have a representative unit on hand that could be weighed. If, for example, the household has one bundle of wood on hand and they consume two bundles a day, then the weight of the bundle is doubled to arrive at a figure for daily consumption. In cases where no wood or charcoal was on hand, respondents were asked where they usually purchase their supplies from, and in what units. Following the interview the survey team would go to that place and conduct a weighing there. Our observation during the pre-test was that since urban households that use fuelwood or charcoal generally *purchase* these fuels (unlike their rural counterparts), they typically have a very good idea of their average daily consumption.

Estimates of kerosene and LPG consumption were derived in a similar fashion, with respondents being asked to provide information on both the units of purchase (e.g. one liter of kerosene, one "flat" of kerosene equivalent to 375 ml, 11 kg canister of LPG, etc.) and the *frequency* of purchase. Electricity consumption was preferably recorded based on available copies of electric bills, but in cases where these were not available the respondent was asked to estimate "average" monthly charges which were then converted to kilowatt-hours using residential sector rate formulas in force at the time.

Completed questionnaires were field-edited by the enumerators the same day of the interview, and subsequently office-edited by a full-time editor within a few days after being conducted in order to locate errors and inconsistencies that could be straightened out without the need for a follow-up interview. In some instances, follow-up visits to households already surveyed were required in order to fill in missing portions or to clarify inconsistent responses. Where needed (such as in the case of open-ended questions), the editor would convert responses to a format suitable for data entry. Two experienced encoders were hired to enter the data from the questionnaires into a D-BASE computer program with built-in variable ranges and automatic skipping features, and a sample of 50 questionnaires was later re-encoded a second time and compared with the data initially encoded for these 50 in order to determine the extent of encoding errors. Out of 17,000 entries (340 variables, 50 respondents) in those 50 questionnaires, the re-encoding identified only two instances in which the initial entry differed from the latter, suggesting that the encoding process was highly accurate. In addition to the encoded data, a 1-2 page written description of the information contained in each questionnaire was also produced during the editing process in order to make note of any peculiarities of the household situation and to provide additional information on particular areas of interest.

Overall, the design and preparation of the household energy survey took over six months, compared with only two months actually spent conducting the interviews. However, we are confident that the extra care taken in selecting a representative sample, designing a carefully-crafted survey instrument, training and closely supervising enumerators in the field, and ensuring the accuracy of the encoding process, all helped to improve the quality of the data actually generated, and thus the validity of the findings.

APPENDIX C

HOUSEHOLD ENERGY QUESTIONNAIRE

Section A: Respondent Qualification/Enumerator Information

A.1 Does the respondent make most of the fuel purchase decisions for the household?
A.2 Does the respondent do most of the household cooking?
A.3 Is the respondent aware of the types and amounts of fuels used in the household?
A.4 Names of enumerators.
A.5 Date of Interview.
A.6 Time begun and time finished.

Section B: Respondent Information

B.1/B.2/B.3 Name/Sex/Age of respondent.
B.4 Highest level of education achieved by respondent?
B.5 Primary occupation of respondent?
B.6 Respondent/Household address.

Section C: Household Information

C.1 Names of household members (list).
C.2 Ages of household members (list).
C.3 Sex of each household member (list).
C.4 Primary occupation of household members (list).
C.5 Monthly income from each primary occupation (list).
C.6 Secondary occupation of household members (list).
C.7 Monthly income from each secondary occupation (list).
C.8 Other sources of income (pensions, remittances from abroad, etc.) for each household member (list).
C.9 How long has the household been residing in Cebu City?
C.10 Place of residence before moving to Cebu City (if applicable)?

Section D: Housing Information

D.1 Status of the dwelling (owned, rented, etc.).
D.2 If rented, what is monthly rent?
D.3 If owned, can respondent estimate imputed monthly rent?
D.4 Is the residence used only as living quarters, or as living quarters and work area?
D.5 If applicable, what kind of work is done on the premises?
D.6 Type of dwelling (single family home, duplex, apartment, etc.).
D.7 How many rooms in the residence?
D.8 Is the place of meal preparation within the house, separate from the house, or both?

Section E: Fuelwood Usage

E.1 Does the household use fuelwood? (If yes, skip to E.5, if no, answer E.2-E.4 and go to Section F)
E.2 If no, what are your reason(s) for not using fuelwood? (open-ended)
E.3 Are any of the following also a reason for your decision not to use fuelwood? (list of pre-coded options)
E.4 Of the above reasons for not using fuelwood, what is the most important reason of all?
E.5 Does the household purchase fuelwood from a store or market?
E.6 How many times a week does the household purchase fuelwood?
E.7 What amount is usually purchased each time?
E.8 How far is the place of purchase from your residence?
E.9 Does the household have fuelwood delivered to it?
E.10 How many times a month is fuelwood delivered?
E.11 How much is usually delivered each time?
E.12 Who delivers fuelwood to the household?
E.13 Does the household collect its own fuelwood?
E.14 How many times a month do you collect fuelwood?
E.15 How much wood is usually collected each time?
E.16 Where is the wood usually collected from (own land, neighbor's land, garbage dump, riverbank, etc.)?
E.17 Which members of the household are usually responsible for collecting fuelwood?
E.18 Does the household use coconut fronds?
E.19 What share of overall household fuelwood use is in the form of coconut fronds?
E.20 Does the household use scrap wood/construction waste?
E.21 Where do you get the scrap wood from?

E.22 What share of overall household fuelwood use is in the form of scrap wood?
E.23 What share, if any, of overall household fuelwood use is for the preparation of animal feeds?
E.24 What share, if any, of overall household fuelwood use is for commercial activities?
E.25 Why do you use fuelwood? (open-ended)
E.26 Are any of the following also a reason for your decision to use fuelwood? (list of pre-coded options)
E.27 Of the above reasons for using fuelwood, what is the most important reason of all?
E.28/E.29/E.30 Do you plan on continuing to use fuelwood for the next one/three/five years?
E.31 Would you like to stop using fuelwood?
E.32 Why do you want to stop using fuelwood?
E.33 What is preventing you from discontinuing your use of fuelwood?
E.34 What was the price you paid for fuelwood the last time you purchased it?
E.35 Have you noticed any fluctuations or changes in the price of fuelwood during the past year?
E.36 Please explain these fluctuations or changes?
E.37 How much wood does your household usually consume in one day? (for E.34 and E.37 actual weighings are conducted)
E.38 Are there times of the year or special occasions when your use of fuelwood increases or decreases substantially?
E.39 What are those occasions and how does it affect fuelwood use (increase or decrease)?
E.40 Do you think there are enough wood/trees in Cebu to meet woodfuel demand for the next 5 years?
E.41 Do you think there are enough wood/trees in Cebu to meet woodfuel demand for the next 10 years?

Section F: Coconut Shell/Husk Usage

F.1 Does the household use coco shells/husks? (If yes, skip to F.5, if no answer F.2-F.4 and go to Sec. G)
F.2 What are your reason(s) for not using coconut shells/husks? (open-ended)
F.3 Are any of the following also a reason for your decision not to use coco shells/husks? (pre-coded)
F.4 Of the above reasons for not using coconut shells/husks, what is the most important reason?
F.5 Does the household purchase coconut shells/husks from a store or market?
F.6 Does the household have coconut shells/husks delivered to it?

F.7 Does the household collect its own coconut shells/husks?
F.8 What share, if any, of total household usage of coconut shells/husks is for preparation of animal feeds?
F.9 What share, if any, of total household usage of coconut shells/husks is for commercial activities?
F.10 Why do you use coconut shells/husks?
F.11 What quantity of coconut shells/husks does your household usually consume in one day/week?

Section G: Charcoal Usage

G.1 Does the household use charcoal? (If yes, skip to G.5, if no, answer G.2-G.4 and go to Section H)
G.2 If no, what are your reason(s) for not using charcoal? (open-ended)
G.3 Are any of the following also a reason for your decision not to use charcoal? (list of pre-coded options)
G.4 Of the above reasons for not using charcoal, what is the most important reason of all?
G.5 Does the household purchase charcoal from a store or market?
G.6 How many times a week does the household purchase charcoal?
G.7 What amount is usually purchased each time?
G.8 How far is the place of purchase from your residence?
G.9 Does the household have charcoal delivered to it?
G.10 How many times a month is charcoal delivered?
G.11 How much is usually delivered each time?
G.12 Who delivers charcoal to the household?
G.13 What share, if any, of overall household charcoal use is for the preparation of animal feeds?
G.14 What share, if any, of overall household charcoal use is for commercial activities?
G.15 What was the price you paid for charcoal the last time you purchased it?
G.16 Have you noticed any fluctuations or changes in the price of charcoal during the past year?
G.17 Please explain these fluctuations or changes?
G.18 How much charcoal does your household usually consume in one week?
G.19 Are there times of the year or special occasions when your use of charcoal increases or decreases substantially?
G.20 What are those occasions and how does it affect charcoal use (increase or decrease)?
G.21 Do you use charcoal only for ironing, only for cooking, or some combination of the two? (If a combination provide an estimate of approximate usage for each)

G.22 Why do you use charcoal for cooking?

Section H: Electricity Usage

H.1 Does the household use electricity? (If yes, skip to H.5, if no, answer H.2-H.4 and go to Section J)
H.2 If no, what are your reason(s) for not using electricity? (open-ended)
H.3 Are any of the following also a reason for your decision not to use electricity? (pre-coded options)
H.4 Of the above reasons for not using electricity, what is the most important reason of all?
H.5 Do you receive electricity from a utility, a neighbor, a generator?
H.6 Do you use electricity for cooking?
H.7 If yes, which of the following electric cooking appliances do you use and what is frequency of use?
H.8 Why do you cook with electricity?
H.9 Do you use electricity for lighting?
H.10 How many of each type of electric lamps (fluorescent, incandescent) are used in the home?
H.11 Do you use electricity for other appliances?
H.12 Which of the following elec. appliances is used in the home and how many of each? (pre-coded list)
H.13 Do you use electricity for commercial activities?
H.14 Which appliances are used for commercial activities?
H.15 Can you estimate monthly electric charges for the household?

Section J (no Section I to avoid encoding errors): LPG Usage

J.1 Does the household use LPG? (If yes, skip to J.5, if no, answer J.2-J.4 and go to Section K)
J.2 If no, what are your reason(s) for not using LPG? (open-ended)
J.3 Are any of the following also a reason for your decision not to use LPG? (pre-coded options)
J.4 Of the above reasons for not using LPG, what is the most important reason of all?
J.5 Is LPG used for cooking?
J.6 Why do you cook with LPG?
J.7 How frequently do you cook with your LPG cooking device?
J.8 Do you use LPG for commercial activities?
J.9 Besides cooking, are there any other uses for LPG in the household (e.g. lighting)?
J.10 What size containers do you purchase LPG in?

J.11 How frequently do you usually need to refill these containers?
J.12 How much do you pay per container?
J.13 Do you pick up the LPG yourself or is it delivered?
J.14 If picked up, how far is the place of purchase from your residence?

Section K: Kerosene Usage

K.1 Does the household use kerosene? (If yes, skip to K.5, if no, answer K.2-K.4 and go to Section L)
K.2 If no, what are your reason(s) for not using kerosene? (open-ended)
K.3 Are any of the following also a reason for your decision not to use kerosene? (pre-coded options)
K.4 Of the above reasons for not using kerosene, what is the most important reason of all?
K.5 Is kerosene used for cooking?
K.6 What type of kerosene stove do you use (e.g. gravity-feed, pressure, wick-type)?
K.7 Why do you use kerosene for cooking?
K.8 How frequently do you cook with your kerosene stove?
K.9 Do you use kerosene for lighting?
K.10 How many of each type of kerosene lamp do you use?
K.11 Do you use kerosene for commercial activities?
K.12 Besides cooking and lighting are there any other uses for kerosene in the home (e.g. fire starter)?
K.13 What size containers do you usually purchase kerosene in?
K.14 How frequently do you have to refill these containers?
K.15 What is the price per container?
K.16 How far is the place of purchase from your residence?

Section L: Other Fuel Usage

L.1 Does the household use any other fuels (e.g. sawdust, corn cobs, wood shavings, etc.)?
L.2 Please list the other fuels used, modes of procurement, and prices paid.
L.3 What are these used for and how much is consumed?

Section M: Household Cooking Practices

M.1 What types of stoves does the household keep on the premises?
M.2 Which stove does the household use the most?
M.3 If applicable, how much did your wood stove cost?

M.4 How frequently do you utilize your wood stove?
M.5 If applicable, how much did your charcoal stove cost?
M.6 How frequently do you utilize your charcoal stove?
M.7 If applicable, how much did your kerosene stove cost?
M.8 How frequently do you utilize your kerosene stove?
M.9 If applicable, how much did your LPG stove cost?
M.10 How frequently do you utilize your LPG stove?
M.11 If applicable, how much did your electric stove cost?
M.12 How frequently do you utilize your electric stove?
M.13 If applicable, how much did your other stove cost?
M.14 How frequently do you utilize your other stove?
M.15 How many times a day does the household usually cook meals?
M.16 On the average, how often does the household purchase cooked food prepared off the premises?
M.17 On the average, how often do household members eat meals out at *carenderias* and eateries?
M.18 Does the household boil its drinking water?
M.19 What stove is usually used for boiling drinking water?
M.20 Does the household boil water for bathing?
M.21 What stove is usually used for boiling water for bathing?
M.22 Has the household changed its primary cooking fuel during the last five years? (excluding temporary switches of short duration due to stove problems or lack of supply)
M.23 From which fuel to which fuel did you switch (list all switches)?
M.24 What was the reason(s) for each switch?
M.25 Ignoring prices, costs of stoves, and whether the fuel is available or not, which fuel do you think is best for cooking?

Section N: Conclusion

N.1 For the purpose of our survey, we need to have a rough estimate of the income of your family from all sources. In which of these groups (display flash card) did your total family income fall for an average month in the past year? (Used to cross-check figures reported for C.5, C.7 and C.8)
N.2 (For enumerator) How would you rate the respondent's degree of cooperation?
N.3 (For enumerator) How would you rate the accuracy/validity of their responses?
N.4 (For enumerator) If another survey were to be done would this be a good household to interview?

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